Core Curriculum

Fifth Edition

Trainee Guide

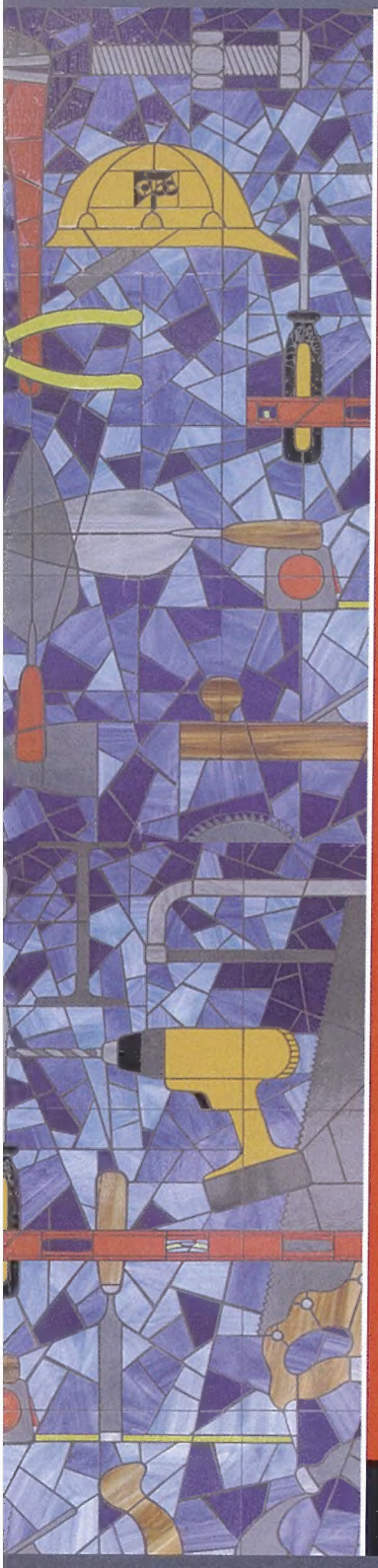
Introduction to Hand Tools

Module 00103-15

Module Three

00103-15

Introduction to Hand Tools



Overview

Every profession has its tools. A surgeon uses a scalpel, a teacher uses a whiteboard, and an accountant uses a calculator. The construction trades require a broad collection of hand tools, such as hammers, screwdrivers, and pliers, that almost every craftworker uses. Even if you are already familiar with some of these tools, everyone needs to learn how to select, maintain, and use them safely. A quality tool may cost more up front, but if properly maintained, it will last for years and remain safely intact.

Module Three

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00103-15
Introduction to Hand Tools

Objectives

When you have completed this module, you will be able to do the following:

1. Identify and explain how to use various types of hand tools.
   a. Identify and explain how to use various types of hammers and demolition tools.
   b. Identify and explain how to use various types of chisels and punches.
   c. Identify and explain how to use various types of screwdrivers.
   d. Identify and explain how to use various types of non-adjustable and adjustable wrenches.
   e. Identify and explain how to use various types of socket and torque wrenches.
   f. Identify and explain how to use various types of pliers and wire cutters.
2. Identify and describe how to use various types of measurement and layout tools.
   a. Identify and explain how to use rules and other measuring tools.
   b. Identify and explain how to use various types of levels and layout tools.
3. Identify and explain how to use various types of cutting and shaping tools.
   a. Identify and explain how to use handsaws.
   b. Identify and explain how to use various types of files and utility knives.
4. Identify and explain how to use other common hand tools.
   a. Identify and explain how to use shovels and picks.
   b. Identify and explain how to use chain falls and come-alongs.
   c. Identify and explain how to use various types of clamps.

Performance Tasks

Under the supervision of your instructor, you should be able to do the following:

1. Visually inspect a minimum of five of the following tools to determine if they are safe to use:
   - Hammer or demolition tool
   - Chisel or punch
   - Screwdriver
   - Adjustable or non-adjustable wrench
   - Socket
   - Torque wrench
   - Pliers
   - Wire cutters
   - Measuring tool
   - Layout tool
   - Level
   - Hand saw
   - File
   - Utility knife
   - Shovel or other earth tool
   - Chain fall or hoist
   - Clamps
2. Safely and properly use a minimum of three of the following tools:
   - Hammer or demolition tool
   - Chisel or punch
   - Screwdriver
   - Adjustable or non-adjustable wrench
   - Socket
   - Torque wrench
   - Pliers
   - Wire cutters
   - Measuring tool
   - Layout tool
   - Level
   - File
   - Utility knife
   - Shovel or other earth tool
   - Chain fall or hoist
   - Clamps
3. Make a straight, square cut in framing lumber using a crosscut saw.

Trade Terms

Adjustable wrench
Ball-peen hammer
Bell-faced hammer
Bevel
Box-end wrench
Carpenter's square
Cat's paw
Chisel
Chisel bar
Claw hammer
Combination square
Combination wrench
Dowel
Fastener
Flats
Foot-pounds
Hex key wrench
Inch-pounds
Joint
Kerf
Level
Miter joint
Nail puller
Newton-meter
Open-end wrench
Peening
Pipe wrench
Planed
Pliers
Plumb
Points
Punch
Rafter angle square
Ripping bar
Round off
Square
Striking (or slugging) wrench
Strip
Tang
Tempered
Tenon
Torque
Try square
Weld

Industry Recognized Credentials

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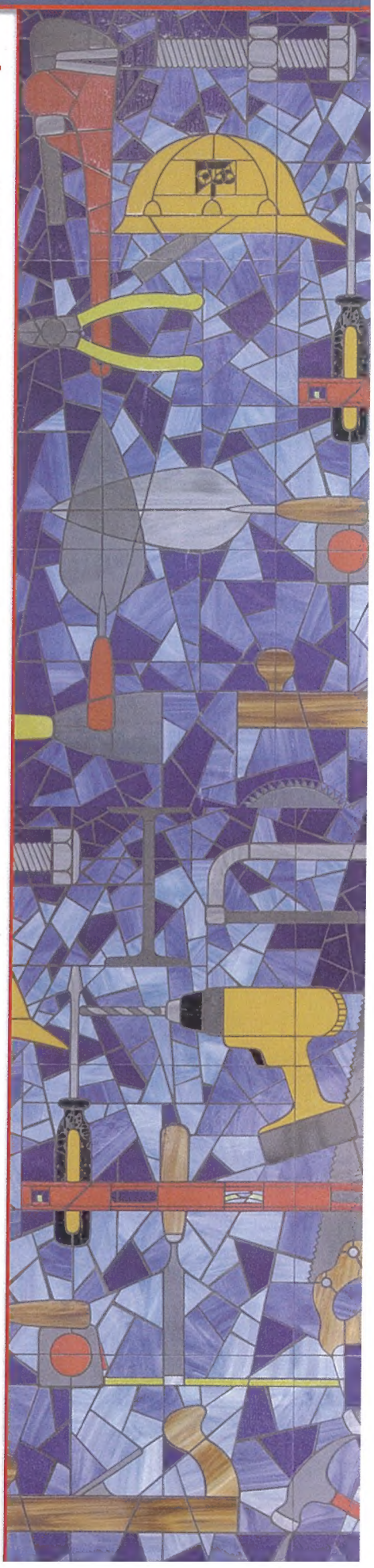
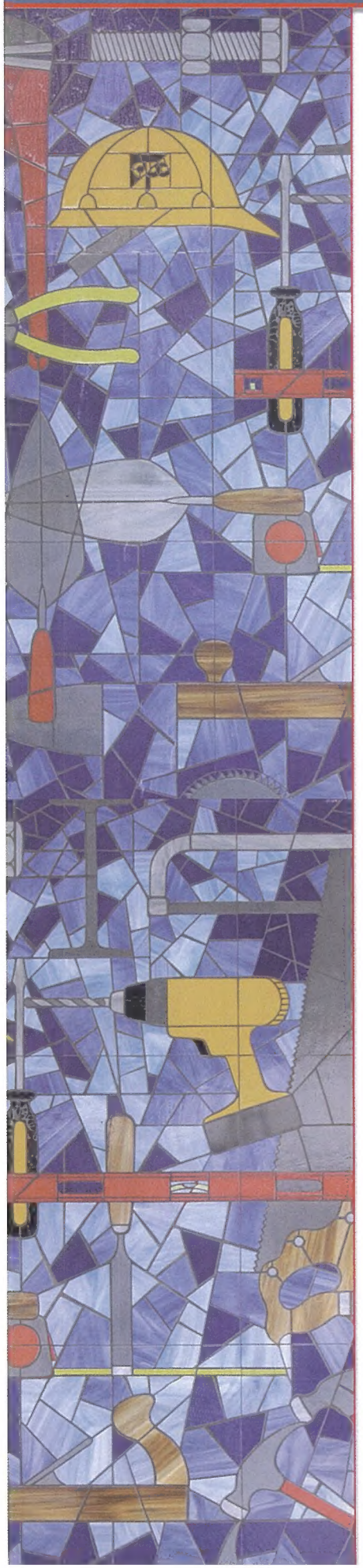
Contents

Topics to be presented in this module include:





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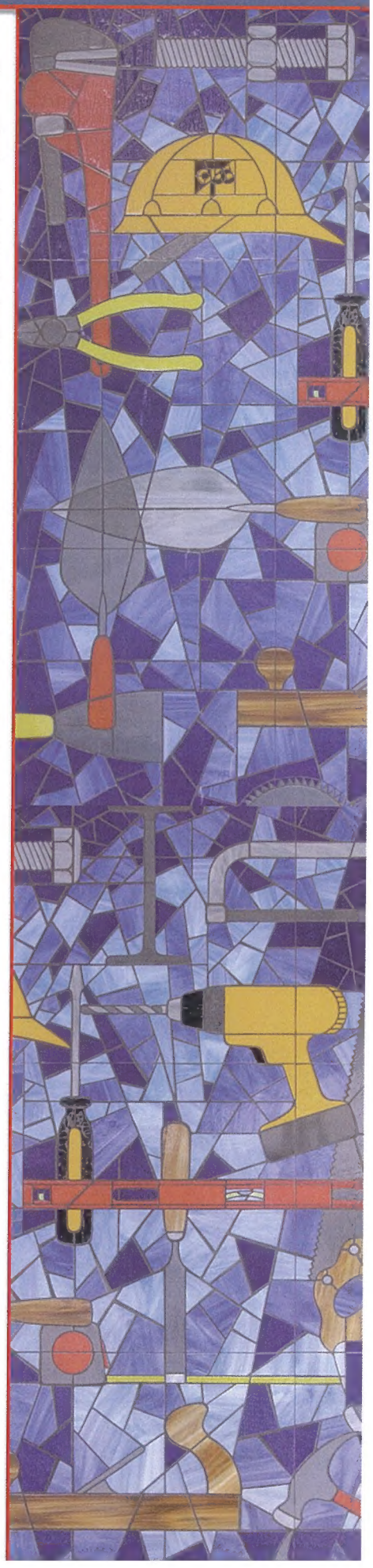

SECTION ONE

1.0.0 COMMON HAND TOOLS

Objective

Identify and explain how to use various types of hand tools.

a. Identify and explain how to use various types of hammers and demolition tools.
b. Identify and explain how to use various types of chisels and punches.
c. Identify and explain how to use various types of screwdrivers.
d. Identify and explain how to use various types of non-adjustable and adjustable wrenches.
e. Identify and explain how to use various types of socket and torque wrenches.
f. Identify and explain how to use various types of pliers and wire cutters.

Performance Tasks

1. Visually inspect the following tools to determine if they are safe to use:
   - Hammer or demolition tool
   - Chisel or punch
   - Screwdriver
   - Adjustable or non-adjustable wrench
   - Socket
   - Torque wrench
   - Pliers
   - Wire cutters
2. Safely and properly use the following tools:
   - Hammer or demolition tool
   - Chisel or punch
   - Screwdriver
   - Adjustable or non-adjustable wrench
   - Socket
   - Torque wrench
   - Pliers
   - Wire cutters

Trade Terms

Adjustable wrench: A smooth-jawed wrench with an adjustable jaw used for turning nuts and bolts. Often referred to as a Crescent® wrench due to brand recognition.

Ball-peen hammer: A hammer with a flat face that is used to strike cold chisels and punches. The rounded end (the peen) is used to bend and shape soft metal.

Bell-faced hammer: A claw hammer with a slightly rounded, or convex, face.

Bevel: To cut on a slant at an angle that is not a right angle (90 degrees). The angle or inclination of a line or surface that meets another at any angle except 90 degrees.

Box-end wrench: A wrench, usually double-ended, that has a closed socket that fits over the head of a bolt.

Cat's paw: A straight steel rod with a curved claw at one end that is used to pull nails that have been driven flush with the surface of the wood or slightly below it.

Chisel: A metal tool with a sharpened, beveled edge used to cut and shape wood, stone, or metal.

Chisel bar: A tool with a claw at each end, commonly used to pull nails.

Claw hammer: A hammer with a flat striking face. The other end of the head is curved and divided into two claws to remove nails.

Combination wrench: A wrench with an open end and a closed end.

Dowel: A pin, usually round, that fits into a corresponding hole to fasten or align two pieces.

Fastener: A device such as a bolt, clasp, hook, or lock used to attach or secure one material to another.

Flats: The straight sides or jaws of a wrench opening; also, the sides on a nut or bolt head.

Foot-pounds: Unit of measure used to describe the amount of pressure exerted (torque) to tighten a large object.

Hex-key wrench: A hexagonal steel bar that is bent to form a right angle. Often referred to as an Allen® wrench.

Inch-pounds: Unit of measure used to describe the amount of pressure exerted (torque) to tighten a small object.

Joint: The point where members or the edges of members are joined. The types of welding joints are butt joint, corner joint, and T-joint.

Level: Perfectly horizontal; completely flat. Also, a tool used to determine if an object is level.

Nail puller: A tool used to remove nails.

Newton-meter: A measure of torque or moment equal to the force of one Newton applied to a lever one meter long.

Open-end wrench: A non-adjustable wrench with a fixed opening at each end that is typically different, allowing it to be used to fit two different nut or bolt sizes.

Peening: The process of bending, shaping, or cutting material by striking it with a tool.

Pipe wrench: A wrench for gripping and turning a pipe or pipe-shaped object; it tightens when turned in one direction.

Pliers: A scissor-shaped type of adjustable wrench equipped with jaws and teeth to grip objects.

Points: Teeth on the gripping part of a wrench. Also refers to the number of teeth per inch on a handsaw.

Punch: A steel tool used to indent metal.

Ripping bar: A tool used for heavy-duty dismantling of woodwork, such as tearing apart building frames or concrete forms.

Round off: To smooth out threads or edges on a screw or nut.

Square: Exactly adjusted; any piece of material sawed or cut to be rectangular with equal dimensions on all sides; a tool used to check angles.

Striking (or slugging) wrench: A non-adjustable wrench with an enclosed, circular opening designed to lock on to the fastener when the wrench is struck.

Strip: To damage the head or threads on a screw, nut, or bolt.

Tempered: Treated with heat to create or restore hardness in steel.

Torque: A rotating or twisting force applied to an object such as a nut, bolt, or screw, using a socket wrench or screwdriver. Torque wrenches allow a specific torque value to be set and applied.

Weld: To heat or fuse two or more pieces of metal so that the finished piece is as strong as the original; a welded joint.

Hand tools are grouped by their purposes. In each group, there are different physical characteristics that determine their individual uses. It is important to know both the purpose and characteristic of each type to complete the task at hand properly and safely. This section presents common hand tools used in the trades, including:

- Hammers and demolition tools
- Chisels and punches
- Screwdrivers
- Wrenches (non-adjustable and adjustable)
- Socket and torque wrenches
- Pliers and wire cutters

In the construction environment, some personal protective equipment (PPE) must be worn consistently. This PPE includes safety glasses, hard-toe safety shoes, hard hats, and gloves. This same PPE should be worn whenever working with hand tools.

Also remember that, when working above the ground, all tools should be controlled so that they cannot fall from your hands or tool belt. Tools should be connected to the tool belt with lanyards to prevent injury to others and damage to the work below.

1.1.0 Hammers and Demolition Tools

Hammers are made in different sizes and weights for specific types of work. The safest hammers are those with heads made of alloys and drop-forged steel. Two of the most common hammers are the **claw hammer** and the **ball-peen hammer**. Demolition tools include various styles of nail pullers and ripping bars. Information on these tools is also presented in this section.

1.1.1 Claw Hammer

The claw hammer (*Figure 1*) has a steel head and a handle made of wood, steel, or fiberglass. This style of hammer is generally associated with carpentry work. The head is used to drive nails, wedges, and **dowels**, and the claw is used to pull nails out of wood. The face of the hammer may be flat or rounded. It is easier to drive nails with the flat face (plain) claw hammer, but the flat face may leave hammer marks when you drive the head of the nail flush (even) with the surface of the work.

A claw hammer with a slightly rounded (or convex) face is called a **bell-faced hammer**. A skilled worker can use it to drive the nail head flush without damaging the surface of the work.

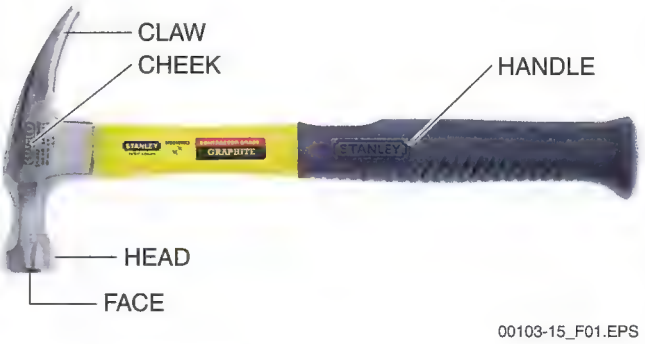

Figure 1 Claw hammer.

Driving a nail with a claw hammer is simple. Using the appropriate PPE, hold the nail and rest the face of the hammer on it to give you a visual starting place. Next, draw the hammer back and lightly tap the nail to start it. Once the nail is started, move your fingers away. Hold the hammer **level** with the head of the nail, using the motion of the wrist, elbow, and shoulder to strike the head squarely with the center of the hammer face. It requires practice to become proficient with this method.

The hammer is designed to produce a certain amount of force on the object it strikes. If you hold the hammer incorrectly, you cancel out the benefits of its design. Always remember to hold the end of the handle even with the lower edge of your palm. The distance between your hand and the head of the hammer affects the force you apply to drive a nail. The closer you hold the hammer to the head, the harder you will need to swing to achieve the desired force. Make it easier on yourself by holding the hammer properly; it takes less effort to drive the nail.

Pulling a nail with a claw hammer is as easy as driving one. First, slip the claw of the hammer under the nail head. Use the leverage of the hammer to pry the nail up until the hammer's handle is nearly straight up (vertical), partially drawing the nail out of the wood. At this point, pull the nail straight up from the wood. Longer and larger nails require more effort, depending on the material in which they are driven. For longer nails, a small block of wood can be placed under the hammer head to elevate it slightly. This strategy can also be used to protect the material underneath the hammer head from being scarred as the nail is pulled out.

Did You Know?

Hammers

The quality of a hammer is important. The strongest (and safest) hammers have heads made from tough alloy (a mixture of two or more metals) and drop-forged steel (a strong steel formed by pounding and heating). Hammers with cast heads—heads formed by being poured or pressed into a mold—are more brittle. They are not suited for construction work because they tend to chip and break. Hammers with heads made of tough alloy and drop-forged steel tend to be more expensive than hammers with cast heads. When it comes to tools, it pays to invest in quality equipment.

1.1.2 Ball-Peen Hammer

A ball-peen hammer (*Figure 2*) is a type of hammer used in metalworking. It has a flat face for striking and a spherical or hemispherical head for **peening** (rounding off) metal or rivets. This hammer is used with **chisels** and **punches** (discussed later in this module). In welding operations, the ball-peen hammer is used to reduce stress in the **weld** by peening or striking the **joint** as it cools.

Ball-peen hammers are also known as engineer's hammers or machinist's hammers. They are classified by weight, which ranges from 4 ounces to 2 pounds (113 g – 0.9 kg).

When using a ball-peen hammer, do not strike the material as though a claw hammer is being used. A ball-peen hammer should strike the material in a controlled manner so that the material is not damaged. Never use a ball-peen hammer to drive nails, because the head of the hammer is made of tough, but milder steel. Continual pounding on nails can deform or damage the hammer's head. A claw hammer is not interchangeable with a ball-peen hammer.

1.1.3 Sledgehammers

A sledgehammer is a heavy-duty tool that is used to drive posts or other large stakes. You can also use it to break up cast iron or concrete. The head of the sledgehammer is made of high-carbon steel and weighs 2 to 20 pounds (0.9 kg to 9 kg). The shape of the head depends on the job the sledgehammer is designed to do. Sledgehammers can be either long-handled or short-handled, depending on the jobs for which they are designed. *Figure 3* shows three styles of sledgehammers.

A sledgehammer can cause injury to you or to anyone working near you. Follow these steps to use a sledgehammer properly and safely:

Step 1 Wear the appropriate PPE, including gloves, eye protection, and hard-toe shoes.

Figure 2 Ball-peen hammer.

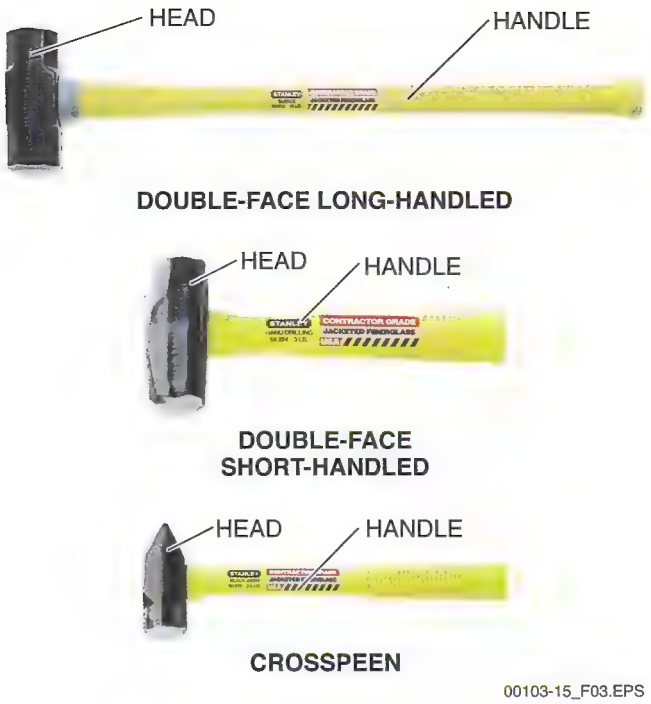

Figure 3 Sledgehammers.

Step 2 Inspect the sledgehammer to ensure that there are no defects.

Step 3 Be sure there is no one nearby that could be struck on the back swing.

Step 4 Hold the sledgehammer with both hands apart (hand over hand).

Step 5 Stand directly in front of the object to be driven.

Step 6 Lift the sledgehammer straight up above the target.

Step 7 Set the head of the sledgehammer on the target.

Step 8 Begin delivering short blows to the target and gradually increase the length and force of the stroke.

WARNING!

Hold the sledgehammer with both hands. Never use your hands to hold an object while someone else drives with a sledgehammer. Doing so could result in serious injury, such as crushed or broken bones.

Do not swing a sledgehammer over your head, with your hands extending beyond the head. Doing so may cause injury to your back and could limit the control you have directing the blow to the target.

1.1.4 Nail Pullers

An existing structure often needs to be torn apart before building can begin. **Nail pullers** and wrecking bars (*Figure 4*) are just the tools for the job.

Three main types of nail-pulling tools are the **cat's paw** (also called nail claws), **chisel bar**, and wrecking bar. There are many names used in the field to describe these tools. The cat's paw is a straight steel rod with a curved claw at one end. It is used to pull nails that have been driven flush with the surface of the wood or slightly below it. The cat's paw is used to pull nails to just above the surface of the wood so they can be pulled completely out with the claw of a hammer or a pry bar.

The chisel bar has a claw at each end and is ground to a chisel-like bevel (slant) on both ends. The chisel bar can be used like a claw hammer to pull a nail. It can also be driven into wood to split and rip apart the pieces.

The wrecking bar (ripping bar, wonder bar, action bar) has a nail slot at the end to pull nails out from tightly enclosed areas. It can also be used as a pry bar to open wooden shipping containers and similar tasks.

Before using a nail puller, it is very important to wear the appropriate PPE to avoid injuries. Once you have donned the PPE, drive the claw into the wood, grabbing the nail head. Once a good grip is achieved, pull the handle of the bar to lift the nail out of the wood.

Figure 4 Nail pullers and wrecking bars.

CAUTION

When manipulating the bar, make sure that you never pull the bar toward your face; always pull the bar toward your shoulder. Also, never push in a direction away from your body, because this may cause you to lose your balance.

1.1.5 Ripping Bars

The ripping bar, also called a pinch, pry, or wrecking bar, can be 12" to 36" long. Ripping bars are generally those that are at the longer end of the range. This is because the length allows them to develop far more leverage and power. They are used for heavy-duty dismantling of woodwork, such as tearing apart building frames or concrete forms. The ripping bar usually has an octagonal (eight-sided) shaft and two specialized ends. Some may have a deeply curved nail claw at one end for nail pulling; others may not be equipped with a nail puller. An angled, wedge-shaped face at the other end is used as a prying tool to pull apart materials that are nailed together.

When using a ripping bar, make sure that you always wear the appropriate PPE. Eye protection is extremely important due to the risk of flying debris. Use the angled prying end to force apart pieces of wood or use the heavy claw to pull large nails and spikes.

CAUTION

When using a ripping bar or a nail puller, a piece of material can break off and fly through the air. Wear a hard hat, safety glasses, and gloves for protection from flying debris. Make sure others around you are similarly protected.

1.1.6 Safety and Maintenance

No matter what the job is, a safe work environment and safe work practices are extremely important to avoid accidents and injuries. Don the required PPE before beginning any work and always be aware of the surroundings before and during the performance of any task.

Become familiar with the following guidelines for safety and maintenance when using all types of hammers:

- Make sure there are no splinters in the handle of the hammer.
- Make sure the handle is set securely in the head of the hammer.
- Replace cracked or broken handles.
- Make sure the face of the hammer is clean.
- Hold the hammer properly. Grasp the handle firmly near the end and hit the nail squarely.
- Do not hit with the cheek or side of the hammer head.
- Do not use hammers with chipped, mushroomed (overly flattened by use), or otherwise damaged heads.
- Do not use a hammer with a cast head.
- Never strike hammer heads together.

The following are additional considerations for safety and maintenance when working with sledgehammers:

- Replace cracked or broken handles before you use a sledgehammer.
- Use the right amount of force for the job.
- Keep your hands away from the object you are driving.
- Never swing until you have checked behind you to make sure you have enough room and no one is behind you.

The following are safety guidelines to consider for ripping and nail pulling:

- Use two hands when ripping to help ensure that there is even pressure on back muscles when pulling.
- Ensure the material holding the nail is braced securely before pulling to prevent injury.

Demolition Tools

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There are many different tools on the market today that are designed for demolition. Small differences in design often make certain tools work far better for a specific task than another style.

The Stanley Fubar shown here, for example, combines the advantages of a pry bar with those of a hammer. Three different strike-able surfaces allow the tool to be driven under or between parts for disassembly. It can be used to pull nails several different ways, and can be used to chop through softer materials such as drywall. Tougher materials can be chopped by first driving the chisel end through and then using the chopping edge. There are many variations on this type of tool.

Most accidents with prying tools occur when a pry bar slips and the worker falls to the ground. Be sure to keep balanced footing and a firm grip on the tool. This technique also helps reduce damage to materials that must be reused, such as concrete forms.

1.2.0 Chisels and Punches

Chisels are used to cut and shape wood, stone, or metal. Punches are used to indent metal, drive pins, and align holes.

1.2.1 Chisels

A chisel is a metal tool with a sharpened, **beveled** (sloped) edge. Wood chisels and cold chisels (*Figure 5*) are discussed in this section. Both types of chisel are made from steel that is heat-treated to make it harder. A chisel can cut any material that is softer than the steel of the chisel. Both cold and wood chisels are manufactured in a variety of shapes and sizes for the many tasks they are used for.

Cold chisels are designed for hard materials such as steel or stone. The most extensively used is the flat chisel. Common cold chisels have an edge that is ground at a 60-degree angle. The wide cutting edge may have slightly rounded corners that do not dig into the metal, which makes it ideal for cutting out sheet metal and cutting off rods. The cross-cut (cape) chisel is manufactured so the cutting edge is slightly wider than the body. This feature keeps the chisel from binding in the cut when chiseling deep grooves. Cross-cut chisels are used for cutting single grooves as well as cutting a grid pattern of grooves when excessive material needs to be cut from a surface. The round nose (half-round) chisel is generally used for specialized work like forming flutes and channels. The diamond-pointed chisel has a square section at the tip with a single bevel. This chisel is typically used for cleaning square internal angles and chipping through plates.

Before using a cold chisel, it is important to be wearing the appropriate PPE, especially the proper eye protection. The first step to using a cold chisel is to secure the object to be cut in a vise. Place the blade of the chisel at the spot where the material is to be cut. Hit the chisel handle with a ball-peen hammer to force the chisel into and through the material. Repeat as necessary.

There are also several different styles of wood chisel. Bevel-edged chisels are easy to push into corners because of the slightly angled edges. This chisel is commonly used for completing dovetail joints. Firmer chisels have a rectangular cross-section blade. This chisel is typically used for heavier work requirements due to their strength. Paring chisels are longer and thinner than their counterparts. The feature of this chisel is its ability to reach deeper into long joints to clean them for a precise fit. Note that some chisels are designed for hand-use only; they should not be struck with a hammer or mallet.

Before using a wood chisel, it is important to be wearing the appropriate PPE, especially proper eye protection. First, outline the recessed area to be chiseled out. Next, set the chisel at one

Figure 5 Cold and wood chisels.

end of the outline, with its edge on the cross-grain line and the bevel facing the recess to be made. Lightly strike the chisel head with a mallet. Repeat this process at the other end of the outline, again with the bevel of the chisel blade toward the recess. Then make a series of cuts approximately ¼" apart from one end of the recess to the other. To pare (trim) away the notched wood, hold the chisel bevel-side down to slice inward from the end of the recess (*Figure 6*).

1.2.2 Punches

A punch (*Figure 7*) uses the impact of a hammer to indent metal before you drill a hole, to drive pins, and to align holes in two parts that are being mated. Punches are made of hardened and **tempered** steel, and they come in various sizes.

Three common types of punches are the center punch, the prick punch, and the straight, or tapered, punch. The center and prick punches are used to make small locating points for drilling holes. The straight punch is used to punch holes in thin sheets of metal; its diameter is consistent for much of its length. The tapered punch, pictured in *Figure 7*, has a slight taper along its length. Straight and taper punches typically have blunt ends rather than a point.

To use a punch, hold it straight up and down with one hand and strike it squarely with a hammer.

Stonemasons

Stone used to be a primary building material. Because of its strength, stone was often used for dams, bridges, fortresses, foundations, and monumental buildings. Today, steel and concrete have replaced stone as a basic construction material. Stone is used primarily as sheathing for buildings, for flooring in high-traffic areas, and for decorative uses.

A stonemason's job requires precision. Stones have uneven, rough edges that must be trimmed and finished before each stone can be set. The process of trimming projections and jagged edges is called dressing the stone. This requires skill and experience using specialized hand tools, such as chisels and sledgehammers. Many craftworkers consider stonework to be an art form.

Stonemasons build stone walls, and they also set stone exteriors and floors, working with natural cut and artificial stones including marble, granite, limestone, cast concrete, marble chips, and other masonry materials.

Figure 6 Proper use of a wood chisel.

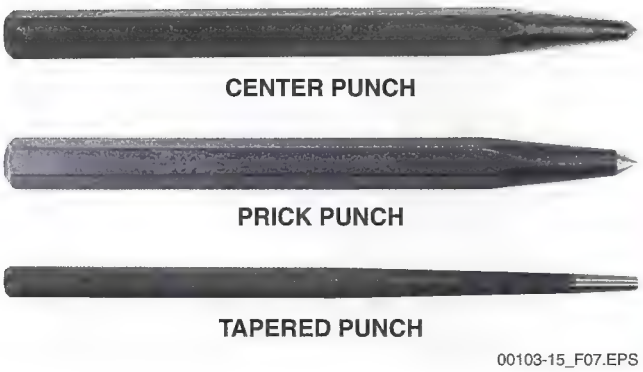

Figure 7 Punches.

1.2.3 Safety and Maintenance

Follow these guidelines for safety and proper maintenance of chisels and punches:

- Always wear the appropriate PPE, such as work gloves and safety goggles.
- Make sure the wood chisel blade is beveled at a precise 25-degree angle so it will cut well.
- Ensure the cold chisel blade is beveled at a 60-degree angle so it will cut well.
- Sharpen the cutting edge of a chisel on an oilstone to produce a keen edge.
- Inspect the point of the punch to ensure it is sharp and not damaged in any way. If necessary, have it sharpened.
- Don't use a chisel, punch, or hammer head that has become mushroomed or flattened (*Figure 8*).
- Ensure the right tool for the job is used.

WARNING! Striking a chisel or punch that has a mushroom-shaped head can cause metal chips to break off. These flying chips can cause serious injury. If a chisel has a mushroom-shaped head, remove the tool from service until it is repaired or replaced according to company policy.

1.3.0 Screwdrivers

A screwdriver is used to tighten or remove screws. It is identified by the type of screw it fits. The most common screwdrivers are slotted (also known as straight, flat, or standard tip) and Phillips head screwdrivers. Other specialized screwdrivers such as a clutch-drive, Torx®, Robertson®, and Allen® head (hex) may also be needed. The three latter screw heads offer greater grip and torque than straight or Phillips screws generally offer. *Figure 9* shows six common types of screw heads.

The screwdrivers designed to fit theses screw heads are described as follows:

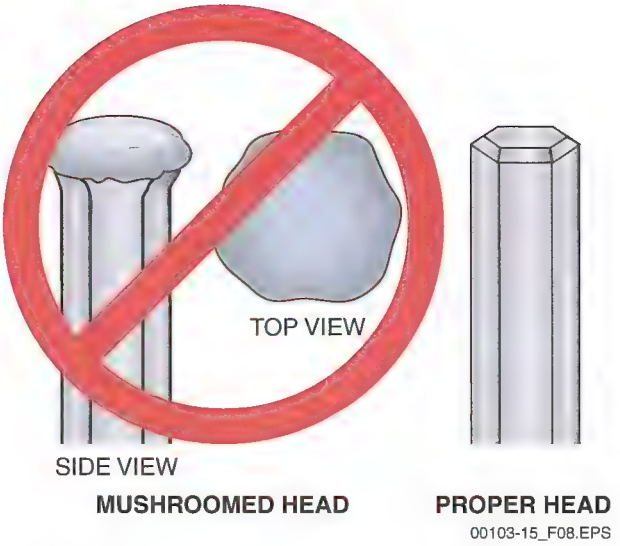

Figure 8 Chisel damage.

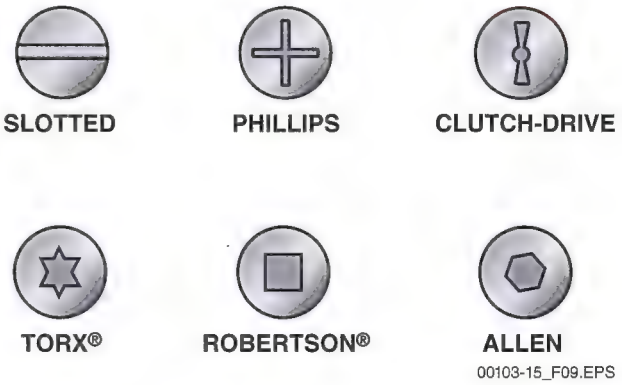

Figure 9 Common screw heads.

- *Slotted* – The most common type of standard screwdriver; it fits slotted screws.
- *Phillips* – The most common type of crosshead screwdriver; it fits Phillips head screws.
- *Clutch-drive* – Has an hourglass-shaped tip that is especially useful for extra holding power, such as when working on cars or appliances.
- *Torx®* – Has a star-shaped tip that is useful for replacing parts such as tailgate lenses. It is widely used in automobile repair work. Torx® screws are used in household appliances as well as lawn and garden equipment.
- *Robertson® (square)* – Has a square drive that provides high torque power. These screwdrivers may be color-coded according to size.
- *Allen® (hex)* – Works with socket-head screws with a female, hex-shaped recess. Hex-key (Allen®) wrenches are L-shaped, hexagonal (six-sided) steel bars. Note that this wrench fits inside the fastener. Hex-key wrenches come in an L-shape or in a T configuration with a handle.

To choose the right screwdriver and use it correctly, it helps to know something about screwdriver construction. Each section has a name, as shown in *Figure 10*. The handle is designed to give you a firm grip. The shank is the hardened metal portion between the handle and the blade. The blade is the formed end that fits into the head of a screw. Industrial screwdriver blades are made of tempered steel to resist wear and to prevent bending and breaking. Good-quality screwdrivers have shanks that run through the length of the handle. Some also have a tip that is hardened, resulting in the darker tip color shown in *Figure 10*.

It is important to choose the right screwdriver for the screw. The blade should fit snugly into the screw head and not be too long, too short, loose, or tight (*Figure 11*). If you use the wrong size blade, you might damage the screwdriver or the screw head. Note that there are several different sizes of each screw type. In addition, there are several styles of screws that are commonly called Phillips screws, but with slight differences. A Reed and Prince screw, for example, looks like the Phillips head but comes to a point at the socket base. The base of a Phillips head screw slot is slightly rounded. Using the wrong screwdriver on these two styles will result in slippage and screw damage.

It is very important to use a screwdriver correctly. Using one the wrong way can damage the screwdriver or **strip** the screw head. Wear work gloves to protect your hands from blade slippage. Once the right size and type of blade for the screw head is chosen, position the shank perpendicular (at a right angle) to your work. Apply firm, steady pressure to the screw head and turn clockwise to tighten, or counterclockwise to loosen.

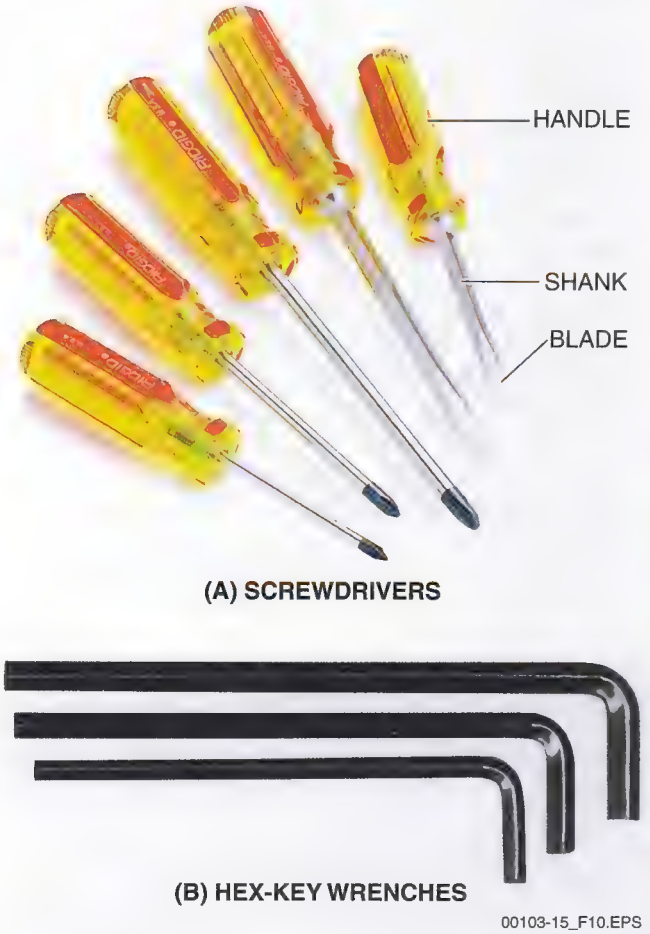

Figure 10 Screwdrivers and hex-key wrenches.

1.3.1 Safety and Maintenance

Properly maintaining a screwdriver not only gives it a longer life, it also helps to prevent injuries. The following guidelines provide for the proper use and maintenance of screwdrivers:

- Keep the screwdriver free of dirt, grease, and grit so the blade will not slip out of the screwhead slot, causing injury or equipment damage.
- Visually inspect your screwdriver before using it. If the handle is worn or damaged, or the tip is not straight and smooth, the screwdriver should be repaired or replaced.
- Never use the screwdriver as a punch, chisel, or pry bar.
- Never use a screwdriver near live wires or as an electrical tester.
- Do not expose a screwdriver to excessive heat.
- Do not use a screwdriver that has a worn or broken handle.
- Never point the screwdriver blade toward yourself or anyone else.

Screws

Screws hold better than nails in most situations. The spiral ridges (threads) help hold the screw tightly inside the material, unlike the smooth surface of most nails. Self-tapping screws end in a sharp point and have sharp threads. These types of screws cut their own threads in the material, eliminating the need to drill a starter hole. In woodworking, however, making a small starter hole with a drill helps keep the wood from splitting. This is especially important in cabinetry, trim work, and furniture construction.

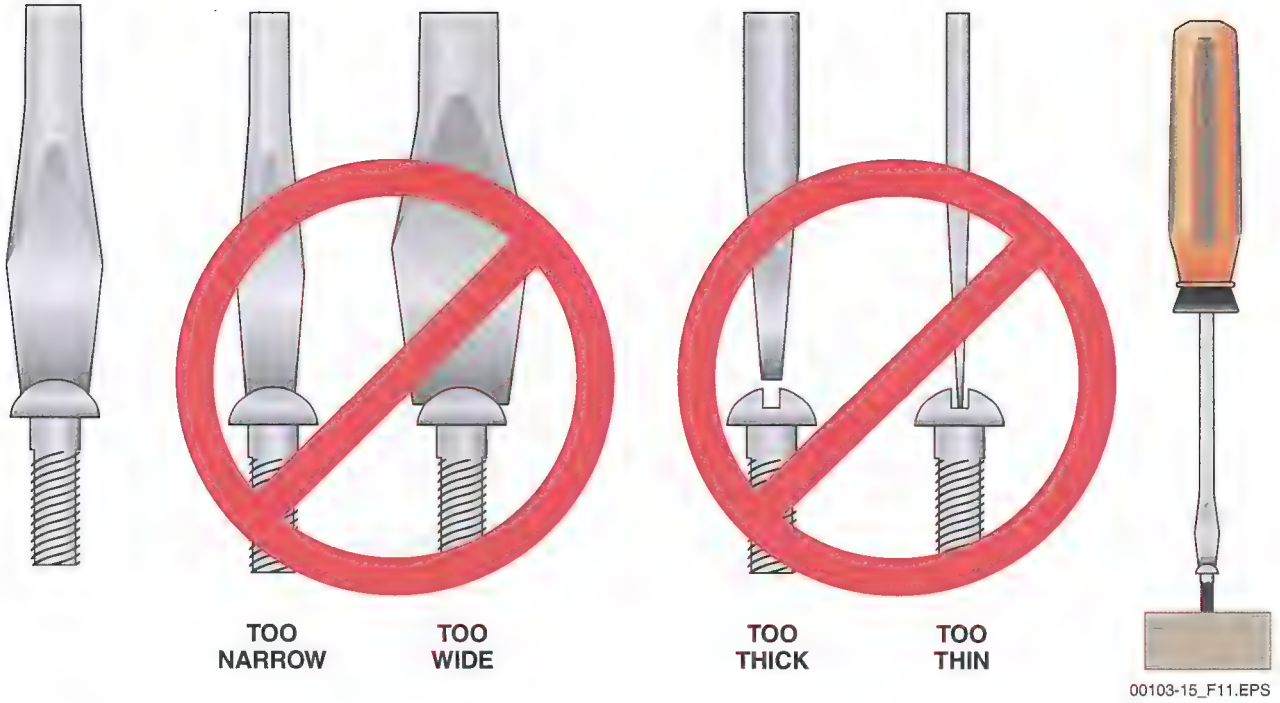

Figure 11 Proper use of a screwdriver.

1.4.0 Wrenches

Wrenches are used to hold and turn screws, nuts, bolts, and pipes. There are many types of wrenches, but they fall into two main categories: non-adjustable and adjustable. Non-adjustable wrenches fit only one size nut or bolt. They come in both Imperial and metric sizes. **Adjustable wrenches** can be adjusted to fit different-sized nuts and bolts.

1.4.1 Non-Adjustable Wrenches

Non-adjustable wrenches (*Figure 12*) include the **open-end wrench**, the **box-end wrench**, the **combination wrench**, and the **striking wrench**.

The open-end wrench is one of the easiest wrenches to use. It has an opening at each end that determines the size of the wrench. Often, the wrench has different-sized openings on each end, such as 7/16" and 1/2" (10.0 mm and 12.7 mm). These sizes measure the distance between the **flats** (straight sides or jaws of the wrench opening) of the wrench, matching the distance across the head of the **fastener**. The open end allows you to slide the tool around the fastener when there is not enough room to fit a box-end wrench.

Box-end wrenches form a continuous circle around the head of a fastener. The ends have six or twelve **points**. A hexagonal shape, typical of bolts and nuts, has six sides. Wrenches with six points are less likely to round-off the flats of a bolt or nut. Although 12-point wrenches are more likely to do so, the advantage is that there are twelve possible positions for the wrench to settle on to the fastener instead of just six. In tight quarters, this is a valuable advantage.

Like open-end wrenches, the ends of a box-end wrench are usually two different sizes. Box-end wrenches offer a firmer grip than open-end wrenches. A box-end wrench is safer to use than an open-end wrench because it will not slip off the sides of certain kinds of bolts quite

Did You Know?

Types of Screws

The demand for different types of screw heads came about due to a number of specific needs in the workplace. For example, Torx® head screws were developed to be compatible with robotic assembly line equipment used in a number of production applications. Phillips heads were developed with four-point contact so that a higher torque could be applied and the head countersunk into the material. Tamper-resistant (snake eye or pig nose) screws were developed to prevent vandalism to public facilities such as school and park restrooms.

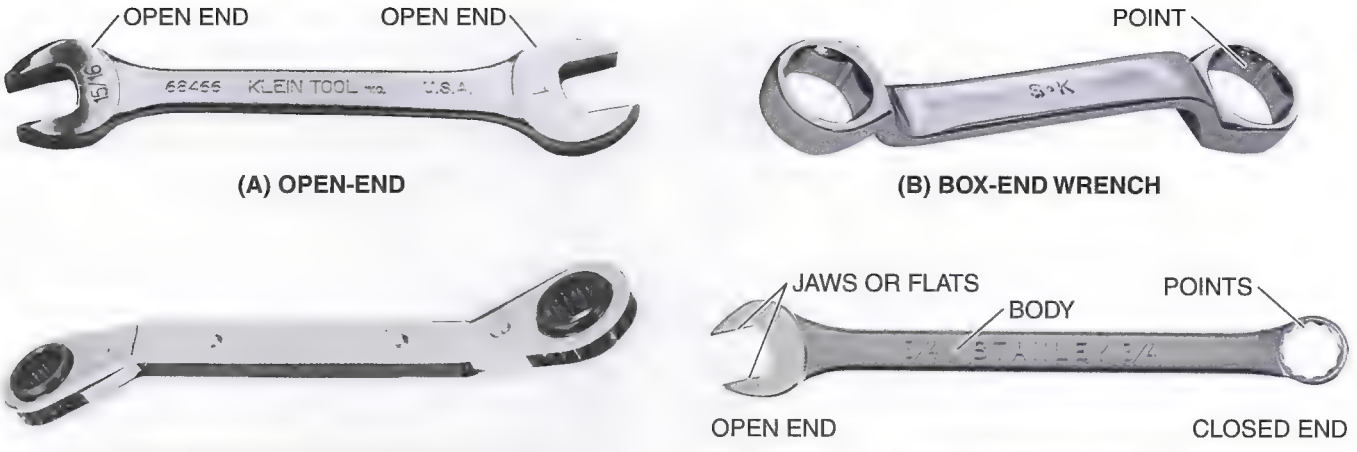

Figure 12 Non-adjustable wrenches.

so easily. Box-end wrenches with a ratcheting feature are popular, but are generally shorter in length, reducing the leverage. Ratcheting box-end wrenches are excellent for assembly work, but are not a good choice for freeing corroded or tight hardware assemblies.

Combination wrenches are, as the name implies, a combination of two types of wrenches. One end of the combination wrench is open and the other is a box-end. Combination wrenches can speed up your work because you don't have to keep changing wrenches. Each combination wrench fits only one size of fastener; each end is the same size.

Striking or slugging wrenches (*Figure 13*) are similar to box-end wrenches in that they have an enclosed circular opening designed to lock onto the fastener. Unlike other wrenches, they are designed to be struck with a hammer to loosen large fasteners. The wrenches have a striking surface to be used with a mallet or handheld sledgehammer. The ends have 6 or 12 points. Striking wrenches are used only in certain situations, such as when a bolt has become stuck to another material because of rust or corrosion. Striking wrenches can damage screw threads and bolt heads. In some cases, it is best to use a power tool, such as an impact wrench, for the task instead. When using a striking wrench, the wrench should be secured with a lanyard to keep it from flying from the fastener out of control. If you are ever in doubt about whether or not to use a striking wrench, ask your instructor or immediate supervisor. Mushroomed hammering surfaces develop just as they do with chisels and punches. Wrenches damaged in such a way should be removed from service until repaired or replaced according to company policy.

When using a non-adjustable wrench, use the correct size wrench for the nut or bolt. Always

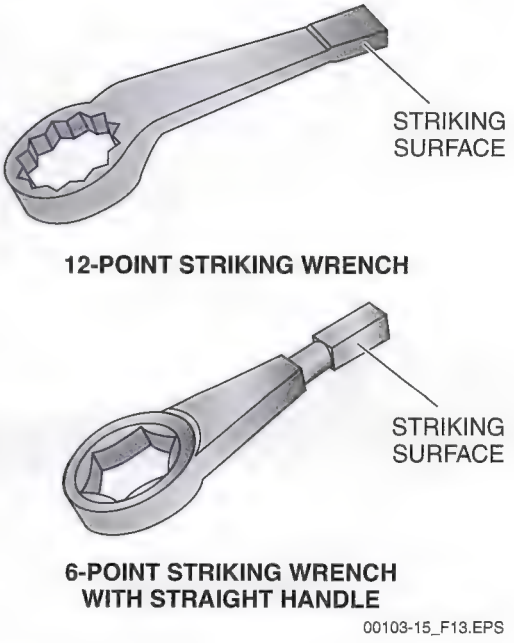

Figure 13 Striking wrenches.

pull the wrench toward you. Pushing the wrench can cause injury.

Be sure that the fit of the wrench is snug and **square** (exactly adjusted) around the nut, bolt, or other fastener. If the fit of the wrench is too loose, it will slip and **round off** or strip the points of the nut or bolt head. Stripped points may make it impossible to remove the fastener.

1.4.2 Adjustable Wrenches

Adjustable wrenches, commonly called Crescent® wrenches due to name recognition, are used to loosen or tighten nuts and bolts like non-adjustable models. Although a fixed-jaw wrench is usually better and safer, an adjustable wrench is a good partner to non-adjustable types. For exam-

ple, while a nut is being tightened with a box-end wrench, the adjustable wrench might be used to hold the bolt head. Adjustable wrenches have one fixed jaw and one movable jaw. The adjusting nut on the wrench joins the teeth in the body of the wrench and moves the adjustable jaw back and forth. These wrenches typically come in lengths from 4" to 24" (0.10 m to 0.61 m), and open as wide as 2 7/16" (0.05 m). Common types include common adjustable wrenches, **pipe wrenches**, and spud wrenches (*Figure 14*).

Pipe wrenches are used to tighten and loosen all types and sizes of threaded pipe. The upper jaw of the wrench is adjusted by turning the adjusting nut. Both jaws have serrated teeth for gripping power on smooth surfaces. The jaw is spring-loaded and slightly angled so you can release the grip and reposition the wrench without having to readjust the jaw.

The spud wrench operates in the same manner as a pipe wrench. However, the jaws are smooth, so it has no value in gripping round pipe. Instead, the wrench is used on large nuts common to plumbing and piping. These large, thin nuts might be found on the bottom of a sink drain, for example.

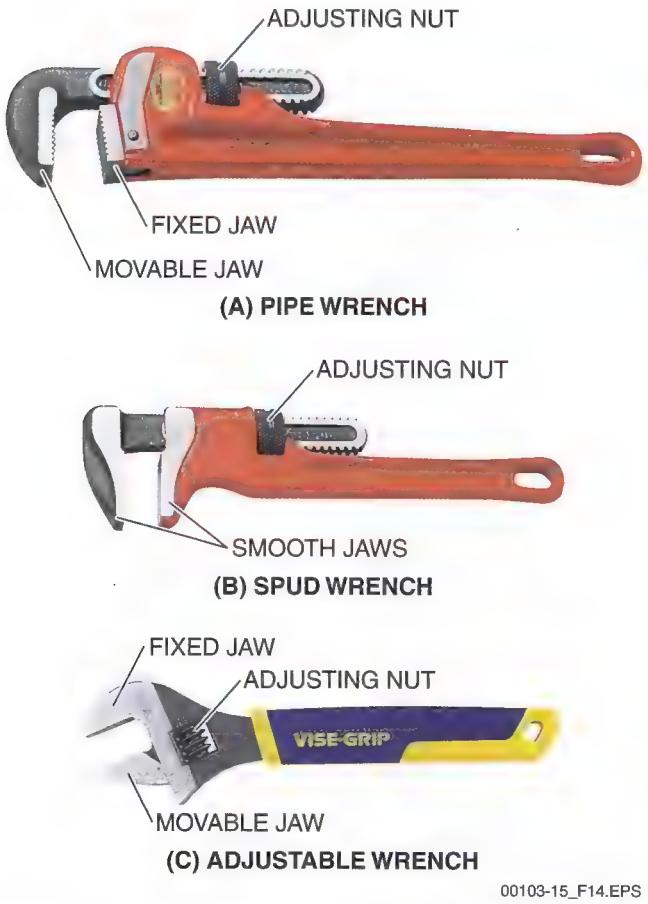

Figure 14 Adjustable wrenches.

To use an adjustable wrench properly, set the jaws to the correct size for the nut, bolt, or threaded pipe. Ensure that tightening pressure is applied to the fixed jaw and not the adjustable jaw (*Figure 15*). Fully tighten the jaws on the piece; it helps to shake the wrench lightly as you use the thumb and forefinger to tighten the adjusting nut. Pull on the wrench to tighten or loosen the component. Pulling towards the body is safer and provides better power than pushing away from the body.

WARNING!

Improperly adjusted jaws could cause the wrench to slip, resulting in loss of balance and serious injury. Whenever possible, pull the wrench toward you. Pushing the wrench can cause injury. If you must push on the wrench, keep your hand open to avoid getting pinched.

1.4.3 Safety and Maintenance

Here are some safety and maintenance guidelines for working with wrenches:

- Focus on your work.
- Pull the wrench toward your shoulder and not toward your face. Leaning into the wrench and pushing could cause serious injury.
- Check the condition of the handle and jaw working surfaces before use.

Spud Wrenches

The definition of a spud wrench varies among the trades. Ridgid® and others refer to the example shown in *Figure 14* as a spud wrench. However, another type of spud wrench looks exactly like a common adjustable wrench on one end, while the opposite end comes to a blunt point, shaped like a tapered punch. This wrench was developed to help structural steel workers who need a wrench to tighten large bolts and nuts. However, before the bolt can be inserted through two pieces of steel, another tool is required to align the holes. The spud wrench handles both tasks without changing tools. In some cases, the wrench on the end is not adjustable, but an open-end or box-style instead.

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Figure 15 Loosening a fastener with an adjustable wrench.

- Keep adjustable wrenches clean. Do not allow mud or grease to clog the adjusting screw and slide.
- Don't use the wrench as a hammer.
- Don't use any wrench beyond its capacity. For example, never add an extension to increase its leverage. This could cause serious injury.

1.5.0 Socket and Torque Wrenches

Socket wrenches use a ratcheting mechanism that holds the socket wrench in place when pulled in one direction and releases when pulled in the opposite direction. This enables the user to quickly tighten or loosen a fastener without removing and refitting the wrench after each turn, or when a complete revolution cannot be made because of poor accessibility. Torque wrenches are a wrench and measuring tool, all in one. These wrenches are used to tighten fasteners that require specific amounts of force to be applied.

1.5.1 Socket Wrenches

Socket wrench sets include different combinations of sockets (the part that fits onto and grips the nut or bolt) and ratcheting handles that are used to turn the sockets. The ratcheting mechanism on the handle attaches to a variety of socket sizes using a square nub. The size of the square nub is referred to as the drive size. Drives are commonly available in ¼", ⅜", and ½" sizes. Much larger sizes are available when required, up to 2½" for industrial work. Ratchet drive sizes are the same globally.

Socket sets are manufactured to fit many Imperial and metric fastener sizes. Most sockets (*Figure 16*) have 6 or 12 gripping points and come in different lengths. Deep sockets, which are longer than standard sockets, allow the socket to accommodate a bolt that protrudes through the nut. A short extension is also shown in *Figure 16*. Extensions are available in a variety of lengths.

Socket sets may contain different types of handles for different uses. The ratchet handle shown in *Figure 16* has a knob used to change the turning direction. Ratchet handles come in a variety of lengths. The longer the ratchet handle, the more leverage can be applied to loosen or tighten the nut or bolt. In addition to ratchets, speed handles and hinge handles are available (*Figure 17*). Speed handles very quickly run a fastener down, but they offer limited torque. However, a speed handle is very handy, especially when a nut is a bit rough and difficult to run down with the fingers. Hinge handles can be used when a ratcheting action is not needed; they are longer and stronger than ratchet handles.

To use sockets and ratchets properly, first select a socket that fits the fastener to be loosened. Place the square end of the socket over the spring-loaded button on the ratchet shaft. Place the socket over the fastener and pull on the handle in the appropriate direction to turn the fastener. Reverse direction by using the button or lever located at the head of the ratchet handle.

Around the World

Metrics and Tools

It is important to know whether the hardware and tools you are working with are metric or Imperial. A proper fit will be unattainable if you try to use an Imperial tool on a metric part. For example, if an Imperial socket is used on a metric bolt, it may tear the points off the bolt head or nut.

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Figure 16 Socket set.

(A) SPEED HANDLE

(B) HINGE HANDLE

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Figure 17 Other socket drive tools.

1.5.2 Torque Wrenches

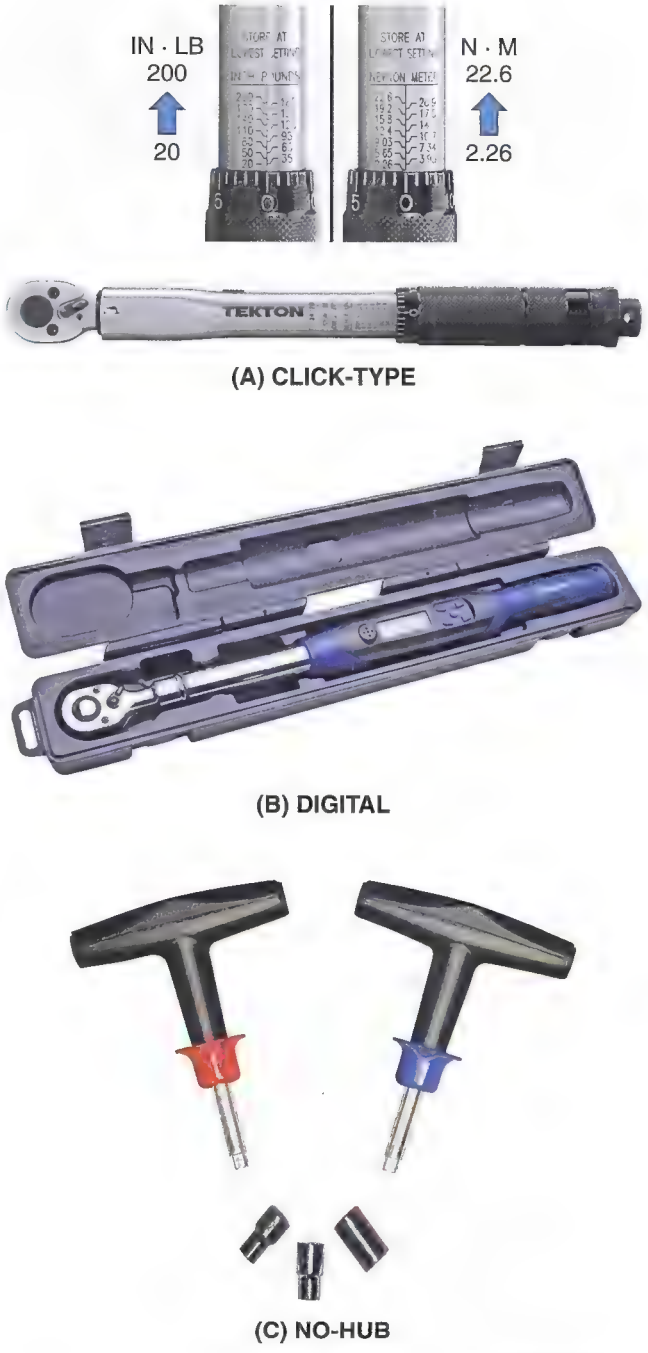
A torque wrench is utilized only when a torque setting is specified for a particular bolt. Torque wrenches measure resistance while applying a twisting force using a common socket. Torque is measured in units of distance × force. In the Imperial system, torque values are usually stated in **inch-pounds** for small fasteners or **foot-pounds** for large fasteners. Inches and feet are the units of distance and the pound is the unit of applied force. In the metric system, the unit of torque measure is **Newton-meters**. Newtons are the measure of force and the meter is the related distance. Users of the metric system often refer to torque as *moment*. Conversion charts allow for easy conversion between the two measurement systems. Torquing procedures will be taught in future modules if the skill is relevant to your chosen craft.

There are three types of commonly used torque wrenches (*Figure 18*). Click-type torque wrenches are preset with the desired torque by adjusting the handle. Once the preset torque is reached, the user feels a slight give in the handle and a clicking sound may be heard. With proper calibration, the benefits of this design include precision and accuracy.

Digital electronic torque wrenches display the desired unit of force needed to tighten a fastener. Measurement details and limit values can be stored and displayed while tightening. The torque values reached on fasteners can even be stored in the wrench's memory where it can be downloaded to a computer. The digital electronic torque wrench is generally used for applications such as validation, in-process, and quality assurance.

No-hub torque wrenches are typically used by plumbers to tighten clamping bands on soil pipes. The T-handled wrench is calibrated at the factory. Once the appropriate torque is reached, the drive socket will stop turning so it does not tighten any further. The colors on the wrench shanks indicate their preset torque values; red is 60 inch-pounds and blue is 80 inch-pounds.

It is important to note that torque wrenches should never be used to loosen fasteners. They are precision instruments that should be used



(A) CLICK-TYPE

(B) DIGITAL

(C) NO-HUB

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Figure 18 Torque wrenches.

only when precision measurement is required. Use other non-precision hand tools to loosen and remove fasteners.

1.5.3 Safety and Maintenance

Follow these guidelines to maintain and use socket, ratchet, and torque wrenches safely:

- Never use a cheater pipe or bar (a longer piece of pipe slipped over the ratchet handle to provide more leverage). This could snap the tool or break the head off the bolt.
- Thoroughly clean sockets and ratchets after each use. Grease and grit can collect in the socket and ratchet nub, causing it to slip and shear the inside edges.
- Before using a torque wrench of any kind, be sure it is properly calibrated for accuracy and reliability. Check torque settings twice.
- Pay close attention. Over-torquing a nut can cause the bolt head to break.

1.6.0 Pliers and Wire Cutters

Pliers are not generally considered wrenches; they are hinged tools. The jaws are adjustable because the handles move around a hinge point. Pliers are generally used to hold, cut, and bend wire and soft metals. Pliers should not be used for tightening or loosening hardware such as bolts and nuts. If any significant torque is applied, they will round off the corners of the bolt or nut head; as a result, wrenches may no longer fit properly on the damaged fastener.

High-quality pliers are made of hardened steel. Pliers come in many different head styles, depending on their use (*Figure 19*). The following types of pliers are the most commonly used. However, it is important to note that there are many variations on these styles:

- Slip-joint pliers
- Long-nose pliers
- Lineman's pliers
- Tongue-and-groove pliers
- Locking pliers

1.6.1 Slip-Joint Pliers

Slip-joint pliers are used to hold and bend wire and to grip and hold objects during assembly operations. They have adjustable jaws with two possible jaw-opening positions. To use slip-joint pliers properly, place the jaws on the object to be held and squeeze the handles until the pliers grip the object. Adjust the jaw position to improve the grip if necessary.

1.6.2 Long-Nose Pliers

Long-nose (needle-nose) pliers are used to get into tight places where other pliers won't reach, or to grip parts that are too small to hold with your fingers. These pliers are useful for bending angles or circles in wire or narrow metal strips. Most have a set of wire cutting jaws near the pivot. Long-nose pliers, like many other types of pliers, are available with spring openers. This is a spring-like device between the handles that keep the handles apart—and the jaws open—unless you purposely close them. This device makes long-nose pliers easier to use.

Tool Lanyards

Tools are as important when working at heights as they are when working on the ground. However, when working at heights, a dropped tool becomes a serious hazard. If the tool has moving parts, such as a battery-powered drill, the fall may destroy it. Almost any dropped tool can cause a serious injury, especially when the impact comes as a complete surprise.

Tool lanyards specifically designed for work in an elevated environment have been introduced by companies like Snap-on®. Tethering tools to the tool belt or wrist can prevent injuries, protect the tools, and eliminate the time lost to retrieve a dropped tool.

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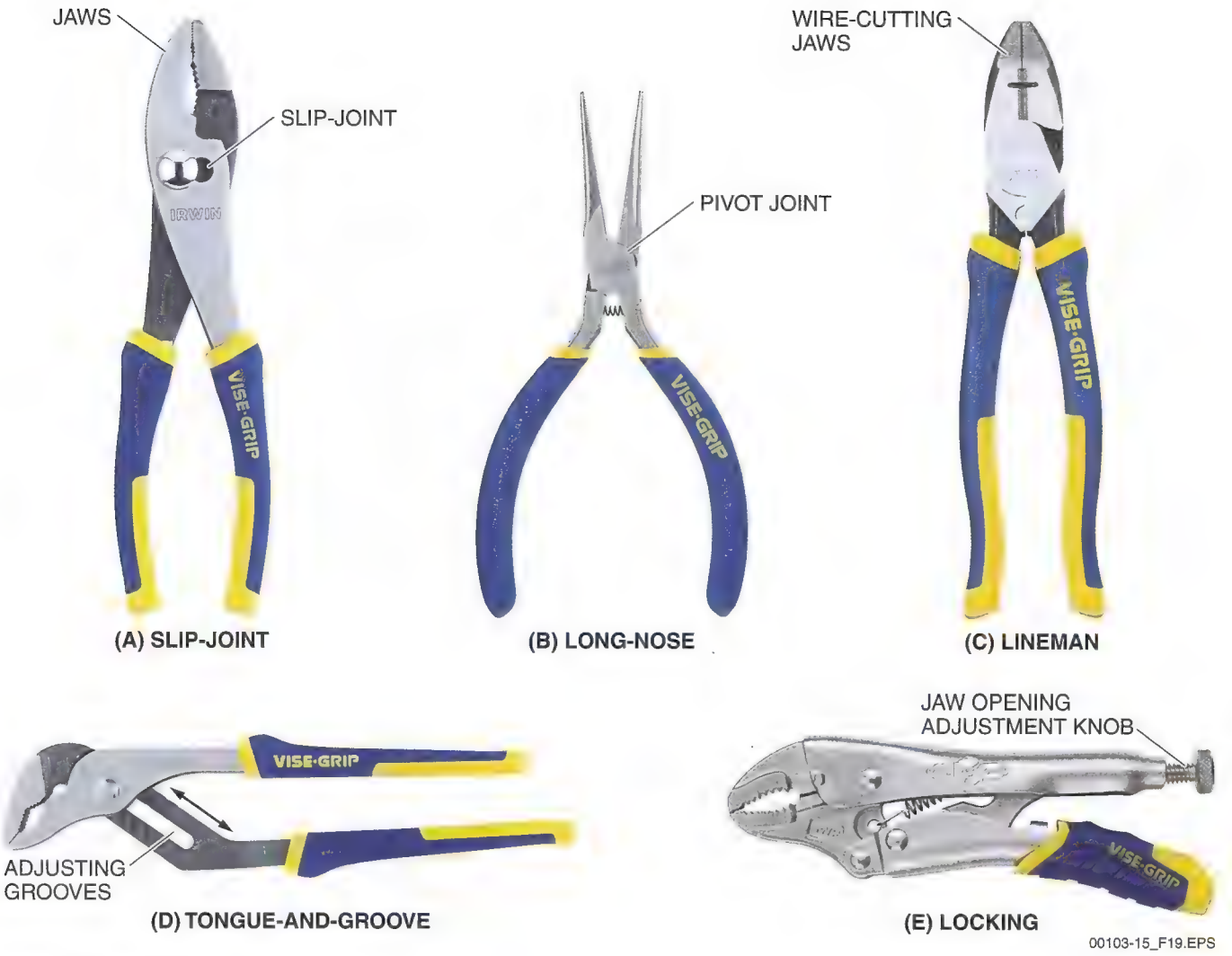

Figure 19 Types of pliers.

The following are guidelines for using long-nose pliers properly:

- If the pliers do not have a spring between the handles to keep them open, place your third or little finger inside the handles to keep them open.
- To cut a wire, squeeze the handles to cut at a right angle to the wire.

1.6.3 Lineman Pliers

Lineman pliers, also known as side cutters, have wider, heavier jaws than slip-joint pliers. They are typically used to cut heavy or large-gauge wire and to hold work. The wedged jaws reduce the chance that wires will slip, and the hook bend in both handles allows for a better grip.

To properly cut wire with lineman pliers, always point the loose end of the wire down. Squeeze the handles to cut at a right angle to the wire.

1.6.4 Tongue-and-Groove Pliers

Tongue-and-groove pliers have serrated teeth that grip flat, square, round, or hexagonal objects. You can set the jaws in any of several positions by slipping the curved ridge into the desired groove. Large tongue-and-groove pliers are often used to grip pipe because the longer handles give more leverage. They are available with three basic jaw designs: straight, smooth, and V-shaped or curved. V-shaped or curved jaws work best with round objects. Straight jaws, as shown on the pliers in *Figure 20*, remain parallel to each other and are better for flat material. Smooth jaws are chosen when serrated jaws may damage a delicate surface.

Use the pliers by opening them to the widest position and place the jaws on the object to be held. Determine which groove provides the correct position and adjust, and then squeeze the handles until the pliers grip the object.

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Figure 20 Straight-jaw tongue-and-groove pliers.

1.6.5 Locking Pliers

Locking pliers clamp firmly onto objects the way a vise does. Due to brand recognition, they are often called Vise-Grips®. They are especially handy for holding metal components together for welding, and for gripping a nut or bolt that has been rounded. A knurled knob on the handle is used to adjust jaw spacing. Simply close the handles to lock the pliers, and release the lock by depressing the lever to open the jaws. There are many different styles of locking pliers; many of these styles have been developed for unique applications. In *Figure 21*, large-jaw locking pliers are being used in a fabrication shop. Note the unusual construction of the locking pliers used to position and hold these materials.

To use locking pliers, first place the jaws on the object to be held. Turn the adjusting screw in the handle until the jaws make contact with the work piece and squeeze the handles together to lock the pliers. Re-adjust the jaws if the locking tension is too loose or too tight. Squeeze the release lever to remove the pliers.

1.6.6 Safety and Maintenance

Pliers may not seem to be a dangerous tool, but they can cause injury if misused. Proper safety precautions and maintenance of pliers are very important. Here are some guidelines to remember when using pliers:

- Wear appropriate PPE, especially if you cut wire.
- Hold pliers close to the end of the handles to avoid pinching your fingers in the hinge.
- Do not extend the length of the handles for greater leverage. Use a larger pair of pliers instead.

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Figure 21 Using locking pliers on the job.

- Hold the short ends of wires to avoid flying metal bits when you cut.
- Always cut at right angles. Don't rock the pliers from side to side or bend the wire back and forth against the cutting blades. Loose wire can fly up and injure you or someone else.
- Oil pliers regularly to prevent rust and to keep them working smoothly.
- Never use pliers around energized electrical wires. Although the handles may be plastic-coated, they are not generally rated to prevent electrical shock.
- Do not expose pliers to direct heat.
- Do not use pliers to turn nuts or bolts; they are not wrenches.
- Do not use pliers as hammers.

Additional Resources

Easy Ergonomics: A Guide to Selecting Non-Powered Hand Tools. National Institute for Occupational Safety and Health (NIOSH), DHHS Publication No. 2004-164. **www.cdc.gov**

Field Guide to Tools. John Kelsey. 2004. Philadelphia, PA: Quirk Books.

1.0.0 Section Review

1. Ball-peen hammers are classified by ____.
   a. length
   b. the size of the head
   c. weight
   d. the material the head is made of

2. The cross-cut chisel is made with the cutting edge wider than the body so it does not bind when chiseling ____.
   a. deep grooves
   b. excess wood
   c. dowels
   d. channels

3. Torx® and Robertson® screws were developed to ____.
   a. improve grip and the torque that can be applied to a screw
   b. increase the length of screws
   c. reduce the different types of screws used for a project
   d. improve the holding power of a screw in wood

4. What type of wrench can also be used as a screwdriver?
   a. Robertson®
   b. Torx®
   c. Combination wrench
   d. Allen®

5. The direction of a ratchet is reversed by ____.
   a. using the button or lever on the ratchet handle
   b. simply reversing direction
   c. removing the socket and turning it around
   d. changing the ratchet handle to a reversible ratchet handle

6. What type of pliers work well for holding fittings together on welding projects?
   a. Needle-nose
   b. Locking
   c. Tongue-and-groove
   d. Lineman

SECTION TWO

2.0.0 MEASUREMENT AND LAYOUT TOOLS

Objective

Identify and describe how to use various types of measurement and layout tools.

a. Identify and explain how to use rules and other measuring tools.
b. Identify and explain how to use various types of levels and layout tools.

Performance Tasks

1. Visually inspect the following tools to determine if they are safe to use:
   - Measuring tool
   - Layout tool
   - Level
2. Safely and properly use the following tools:
   - Measuring tool
   - Layout tool
   - Level

Trade Terms

Carpenter's square: A flat, steel square commonly used in carpentry.

Combination square: An adjustable carpenter's tool consisting of a steel rule that slides through an adjustable head.

Planed: Describing a surface made smooth by using a tool called a plane.

Plumb: Perfectly vertical; the surface is at a right angle (90 degrees) to the horizon or floor and does not bow out at the top or bottom.

Rafter angle square: A type of carpenter's square made of cast aluminum that combines a protractor, try square, and framing square.

Try square: A square whose legs are fixed at a right angle.

Knowing how to achieve precise measurements, straight vertical lines, and accurate leveling are skills that form the foundational knowledge of a skilled craftsperson. An incorrect measurement, crooked vertical line, or improper leveling will have adverse effects as the job progresses. It is important to know how to properly use tools to ensure that the outcome of each measurement is precise.

2.1.0 Rules and Other Measuring Tools

In a previous module, you learned how to read various types of measuring tools. This section presents information on these and other types of measuring tools, and includes guidelines for their use.

Craftworkers use four basic types of measuring tools most often:

- Flat steel rule
- Tape measure
- Wooden folding rule
- Laser measuring tool

Accuracy, ease of use, durability, and readability are a several considerations for choosing a measuring tool.

2.1.1 Steel Rule

The flat steel rule (*Figure 22*) is a simple measuring tool. Flat steel rules are usually 6" or 12" long (15 cm or 30.5 cm), but other lengths are available. Steel rules can be flexible or rigid. While flat steel rules are a very accurate measuring tool, they can also be used as a straightedge for laying out lines and cutting.

2.1.2 Measuring Tape

The tape measure blade (*Figure 23*) is marked in 1/16" increments or smaller. A tape measure may include both Imperial and metric markings. Tape measures are also available with special markings that apply to residential and light commercial construction wall framing.

The concave (or curve) of a tape measure blade is designed to strengthen the blade when it is extended, helping it to hold its shape without bending. Once the blade tip is secure and the proper measurement is established, rotate the blade edge nearest you slightly until it lies flat on the surface, then mark the material. Using this method makes it easier to read the measurement and mark the material more accurately.

2.1.3 Wooden Folding Rule

A wooden folding rule (*Figure 24*) is usually marked in sixteenths of an inch on both edges of each side. Folding rules come in 6' and 8' lengths, with metric versions being commonly available in 2-meter lengths. Because of its stiffness, a folding rule is better than a cloth or steel tape for

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Figure 22 Steel rule.

measuring vertical distance. This is because, unlike tape, it can be held straight up. This makes it easier to measure some distances, such as those that might require someone on a ladder to reach one end. Like a tape measure, the folding rule can also have special marks at the 16", 19.2", and 24" increments to make wall framing easier. These markings may differ on metric models due to differences in construction standards.

2.1.4 Laser Measuring Tools

A laser measuring tool (*Figure 25*) is a battery-powered, electronic version of a tape measure. This hand-held tool works by pointing it at a specific object and then pressing a measurement button on the control panel. When the button is pressed, a laser shoots out at the object and a reading is sent back to the instrument and displayed on the screen. Laser measuring tools can be designed to register and record in both Imperial and metric measurements. These tools are precision instruments, so ensure they are handled with care and stored appropriately.

The following are some of the advantages a laser measuring tool has over a traditional tape measure:

- Measurements required at higher elevations can be taken from ground level.
- Longer measurements can be taken. Some construction laser measuring tools measure from 1' up to 600' (0.3 m up to 200 m). A target plate may be required for long distances with higher power lasers.
- Some laser measuring tools have buttons on the control panel that make length-related calculations (such as addition, subtraction, and area) easier to perform.
- A number of measurements can be electronically stored on the tool, so that measurements can be written down all at once after the task is completed.

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Figure 23 Tape measure.

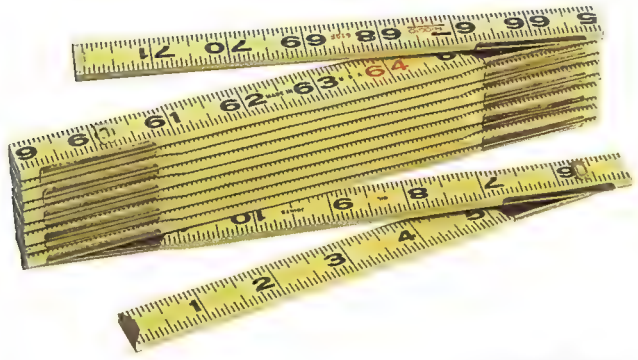

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Figure 24 Wooden folding rule.

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Figure 25 Laser measuring tool.

- Some laser measuring tools can have built-in electronic levels and spirit levels.

Some disadvantages of a laser measuring tool are that it can have an accuracy range of 6$\frac{1}{16}$" (1.59 mm). Over some distance, this may not represent a problem. It is also difficult to make distant measurements in very hot or smoky environments due to the beam bouncing from particle to particle in the atmosphere, causing the beam to scatter. In addition, some targets may be too reflective, causing the beam to produce inaccurate measurements.

2.1.5 Safety and Maintenance

Follow these guidelines to ensure measuring tools are safely used and maintained properly:

- Occasionally apply a few drops of light oil on the spring joints of a wooden folding rule and steel tape.
- Wipe moisture off steel tape to keep it from rusting.
- Don't kink or twist steel tape, because this could cause it to break.
- Don't use steel tape near exposed electrical parts.
- Don't let laser measuring tools get wet.

2.2.0 Levels and Layout Tools

A level is a tool used to determine how level a horizontal surface is or how **plumb** a vertical surface is. If a surface is described as level, it means it is exactly horizontal. If a surface is described as plumb, it means it is exactly vertical. Levels are used to determine how near to exactly horizontal or exactly vertical a surface is. In most cases, the level allows you to adjust to a level or plumb condition before assembling components.

Layout tools also include carpenter's and combination squares, which are covered here. Note that there are various versions of squares designed specifically for a given craft. For example, although a carpenter's square and a pipefitter's square may appear the same initially, they often have different markings and other information important to their specific type of work. Other layout tools include chalk lines and plumb bobs.

2.2.1 Spirit Levels

The spirit level (*Figure 26*) is the most commonly used leveling instrument in the construction trade. The spirit level got its name because the

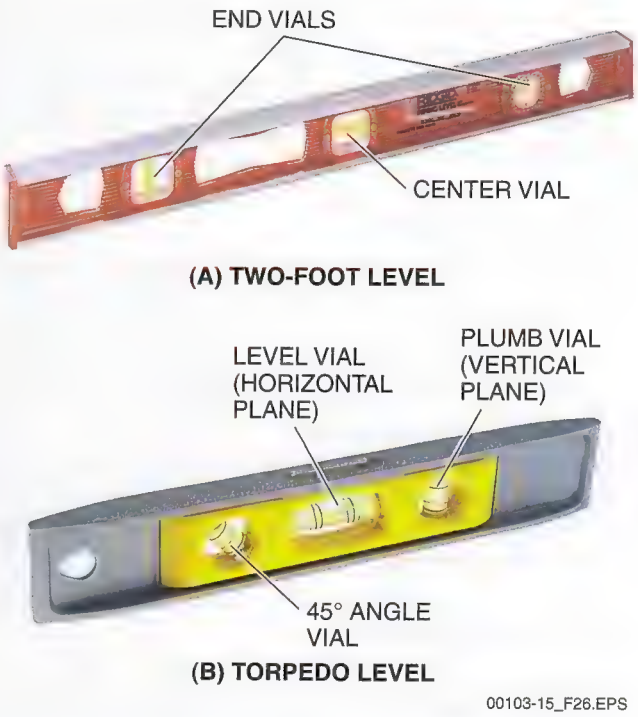


Figure 26 Spirit levels.

Precision Measuring Tools

Laser measuring tools are becoming increasingly common in the construction industry. They allow you to make precise and reasonably accurate measurements. Precision measuring tools, such as micrometers and calipers, make it possible to accurately measure parts that are being machined to one ten-thousandth of an inch (0.0001") or 2.54 microns. However, a standard micrometer's smallest division is 0.001 (25.4 microns). Digital micrometers are available that can read increments as small as 0.00005", or 1.27 microns. Of course, there are metric micrometers as well.

vials in it are filled with alcohol, which is sometimes called spirits. Alcohol is used because it does not freeze.

Most spirit levels are made of tough, lightweight metals such as magnesium or aluminum, or types of plastic that can reliably maintain their true form. They typically have three vials filled with alcohol. The center vial is used to check for level, and the two end vials are used to check for plumb. Some spirit levels, like the torpedo level shown in *Figure 26*, will also show a true 45-degree angle. Spirit levels come in a variety of sizes; the longer the level, the greater its accuracy.

The amount of liquid in each vial is intentionally not enough to fill it, so there is always a bubble in the vial. When the bubble is centered precisely between the lines on the vial, the surface is either level (perfectly horizontal) or plumb (perfectly vertical) as shown in *Figure 27*. Before placing a level against a surface, be sure that there is no debris that will prevent an accurate measurement.

2.2.2 Digital Levels

Digital levels provide a digital readout of degrees of slope, plus an inches-per-foot of rise to lay out stairs and roofs. Some may also use a simulated bubble display for a more traditional appearance. Digital levels, like the one shown in *Figure 28*, are becoming more common on construction sites due to their versatility. Always handle and store a digital level carefully to avoid damaging it, and always follow the manufacturer's recommendations for operation.

2.2.3 Laser Levels

With a laser level (*Figure 29*), a single worker can accurately and quickly establish plumb, level, or square measurements. Laser levels are used to set foundation levels, establish proper drainage slopes, square framing, and align plumbing and electrical lines. A laser level may be mounted on a tripod, fastened onto pipes or framing studs, or be suspended from ceiling framing. Levels for professional construction jobs are housed in sturdy casings designed to withstand job site conditions. These tools come in a variety of sizes and weights, depending on the application. They are primarily used for leveling over a significant distance. Always handle and store laser levels carefully, and follow the manufacturer's recommendations for use.

WARNING! Never look directly at the laser beam that is generated by a laser tool. It can impair your vision and damage your eyes.

2.2.4 Safety and Maintenance

All levels are considered to be precision instruments that must be handled with care. Unless the user looks directly at the laser, there is little risk of personal injury when working with this particular tool. Remember these guidelines when working with levels:

- Never look directly at the laser.
- Replace a level if a crack or break appears in any of the vials.
- Keep levels clean and dry.
- Do not bend or apply too much pressure on a level.
- Do not drop or bump a level.

2.2.5 Squares

Squares (*Figure 30*) are used for marking, checking, and measuring. The type of square you use depends on the type of job and your preference.

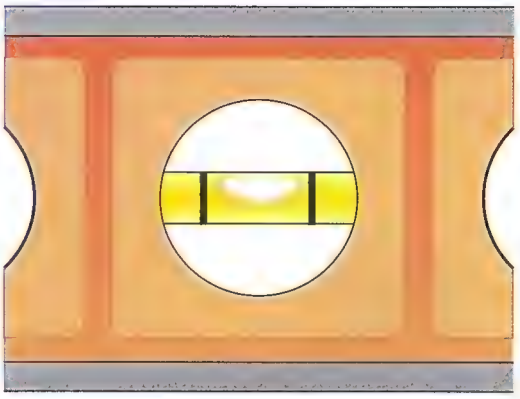
Bricklayers

Working with your hands to create buildings is a time-honored craft. People have used bricks in construction for more than 10,000 years. Archaeological records prove that bricks were one of the earliest man-made building materials.

In bricklaying, it is important that each course (row) of bricks is level and that the wall is straight. An uneven wall is weak as well as unattractive. To ensure that the work stays true, a bricklayer uses a straight level and a plumb line.

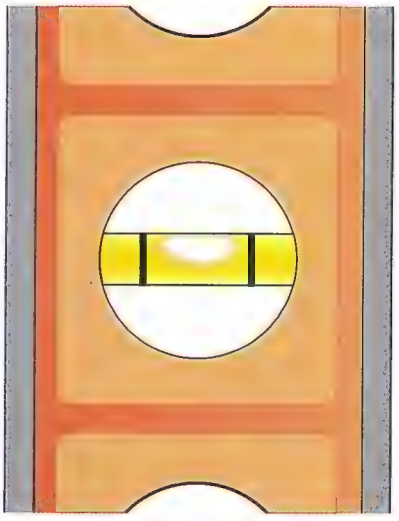
Today, bricklayers build walls, floors, partitions, fireplaces, chimneys, and other structures with brick, precast masonry panels, concrete block, and other materials. They lay brick for houses, schools, sports stadiums, office buildings, and other structures. Some bricklayers specialize in installing heat-resistant firebrick linings inside huge industrial furnaces, called refractory brick.

(A)



(B) LEVEL

(C)



(D) PLUMB

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Figure 27 Levels showing level and plumb.

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Figure 28 Digital level.

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Figure 29 Laser level.

Common squares are the **carpenter's square**, **rafter angle square** (also called the speed square or magic square), **try square**, and **combination square**.

The carpenter's square, or framing square, is shaped like an L and is often used for squaring up sections of work such as wall studs and sole plates to ensure that they are at right angles to each other. As shown in *Figure 31*, it is also used to mark cutting lines, especially when working with wide lumber dimensions. Carpenters use it for laying out cuts in common rafters, hip rafters, and stairs. The carpenter's square has a 24" (61 cm) blade and a 16" (41 cm) tongue, forming a right angle. The blade and tongue are marked with Imperial inches and fractions of an inch, or metric centimeters and millimeters. You can use the blade and the tongue as a rule or a straightedge. Tables and formulas are printed on the blade for making quick calculations such as determining area and volume.

The rafter angle square is another type of carpenter's square, frequently made of cast aluminum or tough plastics. It is a combination protractor, try square, and framing square. It is marked with degree gradations for fast, easy layout. The square is small, so it is easy to store and carry. By clamping the square on a piece of lumber, you can use it as a guide when cutting with a portable circular saw.

The try square has a fixed, 90-degree angle and is used mainly for woodworking. Like other squares, it can be used to lay out cutting lines at 90-degree angles; to check the squareness of adjoining surfaces; to check a joint to ensure it is square; and to check if a **planed** piece of lumber is warped or cupped (bowed).

The combination square has a ruled blade that slides through a head. The position of the ruled blade can be changed in relation to the head. The head is marked with 45-degree and 90-degree angle measures. Some squares also contain a small spirit level and a metal scribe. The combination square is one of the most useful tools for layout work. It can be used as a straightedge and marking tool; to check work for squareness; mark 90-degree and 45-degree angles; check level and plumb surfaces; and measure lengths and widths. Good combination squares have all-metal parts, a blade that slides freely but can be clamped securely in position, and a glass-tube spirit level.

To mark a 90-degree angle using a combination square (*Figure 32*), set the blade at a right angle (90 degrees). Position the square so that the head fits snugly against the edge of the material to be marked. Start at the edge of the material and use the blade as a straightedge to guide the mark.

To mark a 45-degree angle using a combination square (*Figure 33*), set the blade at a 45-degree angle. Position the square so that the head fits snugly against the edge of the material to be marked. Start at the edge of the material and use the blade as a straightedge to guide the mark.

2.2.6 Use and Maintenance

Follow these guidelines for using squares:

- Do not use a square for something it wasn't designed for, especially prying or hammering.
- Keep the square dry to prevent it from rusting.
- Use a light coat of oil on the blade, and occasionally clean the blade's grooves and the setscrew.
- Do not bend a square.

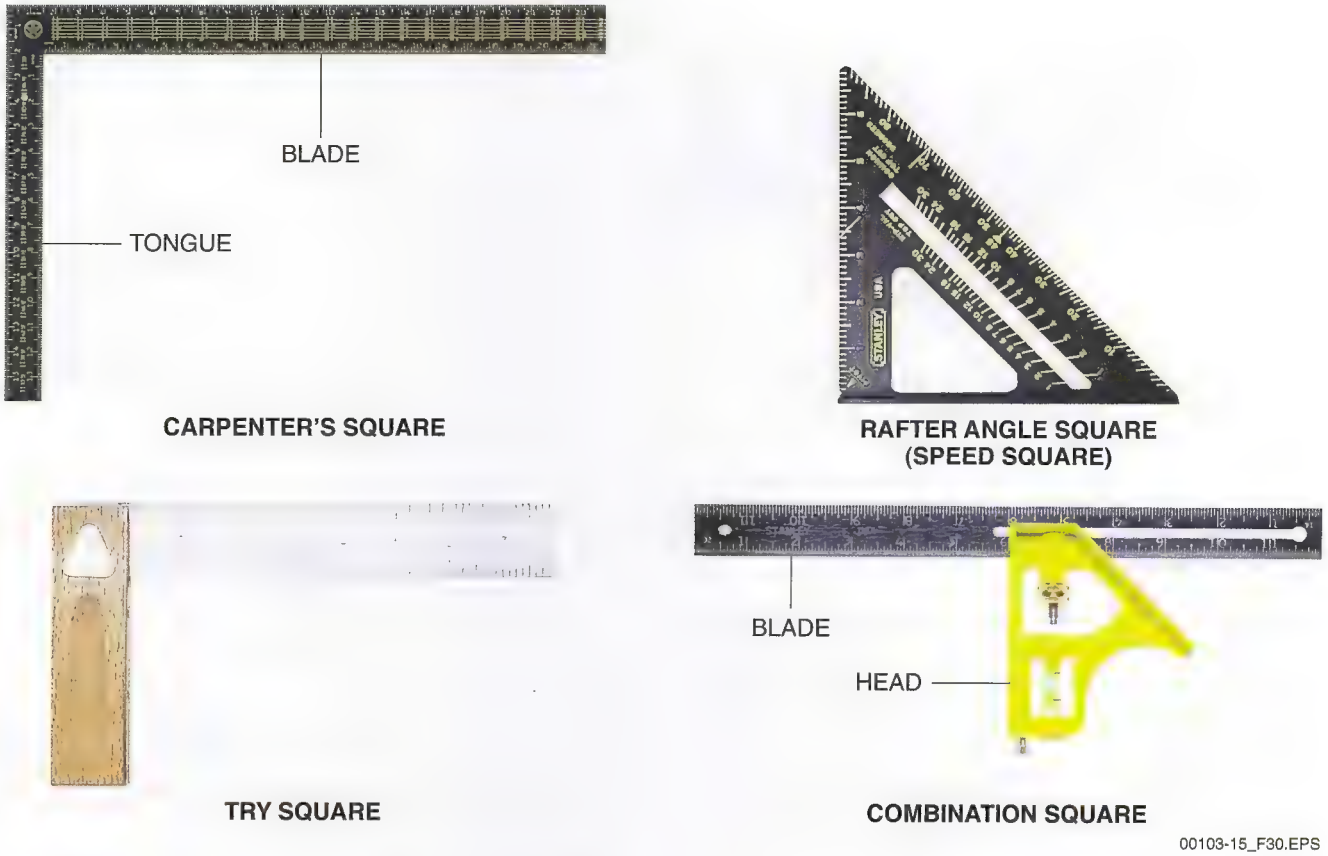

Figure 30 Types of squares.

Figure 31 Marking a cutting line.

- Do not drop or strike the square hard enough to change the angle between the blade and the head.

A square can be checked to ensure that it has not become distorted. Use it against a straight and true surface to scribe a line. Then turn the square over and scribe a line in the same location. The two lines should be identical and true to each other.

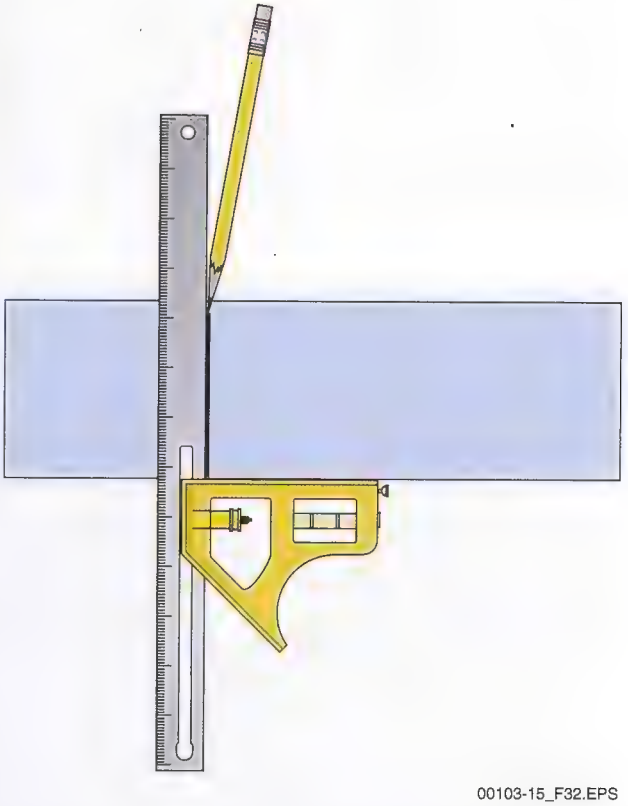

Figure 32 Using a combination square to mark a 90-degree angle.

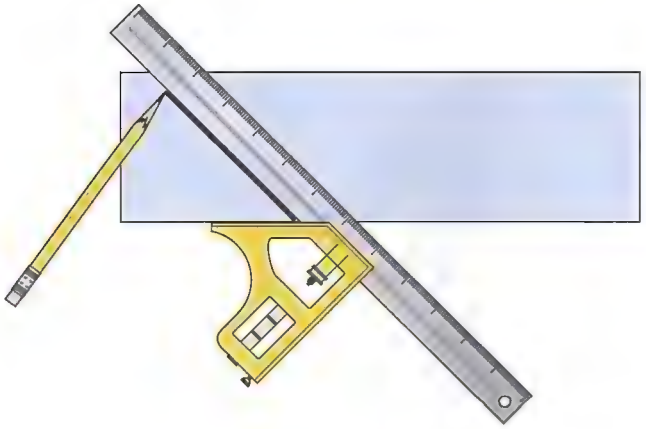

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Figure 33 Using a combination square to mark a 45-degree angle.

2.2.7 Plumb Bob

The plumb bob, which is a pointed weight attached to a string (*Figure 34*), uses the force of gravity to make the line hang vertical, or plumb. Plumb bobs come in different weights, with 20-, 16-, 12-, and 8-ounce (≈566-, 454-, 340-, and 227 g) weights being the most common. Although metric equivalents are provided here, metric plumb bobs may be found in even weights such as 570 or 450 grams. The most important criteria is to use one with enough weight to maintain its position.

When the weight is allowed to hang freely and is motionless, the string is plumb (*Figure 35*). You can use a plumb bob to make sure a wall or a doorjamb is vertical. When installing a post under a beam for example, a plumb bob can show what point on the floor is directly under the section of the beam that requires support.

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Figure 34 Plumb bob.

Follow these steps to use a plumb bob properly:

Step 1 Make sure the line is attached at the exact top center of the plumb bob.

Step 2 Hang the bob from a horizontal member, such as a doorjamb, joist, or beam. Be careful not to drop a plumb bob on its point; it could be damaged and cause inaccurate readings.

Step 3 When the weight is allowed to hang freely and stops swinging, the string is plumb.

Did You Know?

Geometry and the Square

Some combination squares, like the one shown here, can be set at any angle. The head has a built-in precision protractor. Like other combination squares, the metal rule can slide back and forth in the head, then locked in the desired position. Combination square sets like this one are used to measure and mark any angle, including the common 30-, 45-, 60-, and 90-degree angles. When you use a combination square to measure and mark materials, you are incorporating basic geometric principles to your work.

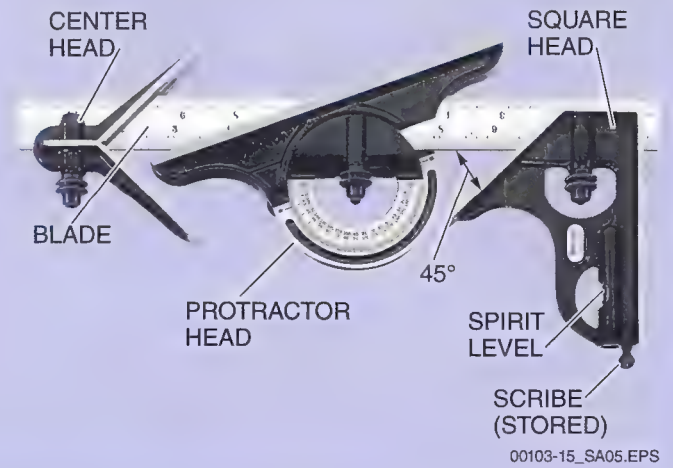

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Figure 35 Using a plumb bob.

Step 4 When you are using a plumb bob outdoors, be aware that the wind may blow it out of true vertical.

Step 5 Mark the point directly below the tip of the plumb bob. This point is precisely below the point where you attached the bob above.

2.2.8 Chalk Lines

Chalk lines are used to create long, straight lines on smooth surfaces. A chalk line is a tool with a piece of string or cord that is coated with chalk. The line is stretched taut between two points and then snapped to release a chalky line to the surface.

The chalk line contains a line on a reel (*Figure 36*). The case is filled with colored chalk powder. The line is automatically chalked each time you pull it out of the case. Some models can serve as a relatively lightweight plumb bob as well.

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Figure 36 Chalk line and chalk.

To snap a chalk line, simply pull the line from the case and secure one end. Stretch the line between the two points to be connected. After the line has been pulled taut, pull the string straight up or away from the work and then release it. This marks the surface underneath with a straight line of chalk (*Figure 37*). Spraying the chalk line with clear lacquer will prevent it from wearing away for a reasonable period of time. Otherwise, the chalk is easily washed away by rain or quickly distorted by foot traffic. Store the chalk line and chalk supply in a dry place, as damp or wet chalk is unusable.

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Figure 37 Using a chalk line.

Mercury

Years ago, the highest-quality plumb bobs were made with a large cavity in the center, which was then filled with mercury to increase the weight and concentrate the weight directly above the bob's center point. We have since learned about the potential health hazards of mercury and this practice has been discontinued.

Additional Resources

Easy Ergonomics: A Guide to Selecting Non-Powered Hand Tools. National Institute for Occupational Safety and Health (NIOSH), DHHS Publication No. 2004-164. **www.cdc.gov**

Field Guide to Tools. John Kelsey. 2004. Philadelphia, PA: Quirk Books.

2.0.0 Section Review

1. Why are wooden folding rules good for measuring vertical distances?
   a. They are extra long.
   b. They have hinges.
   c. They are extra wide.
   d. They are stiffer than a measuring tape.

2. What measuring tool is useful when higher elevation measurements need to be taken from ground level?
   a. Laser measuring tool
   b. Wooden folding rule
   c. Tape measure
   d. Steel rule

3. The carpenter's square is also called a ____.
   a. framing square
   b. speed square
   c. try square
   d. magic square

4. What type of square may be used as a guide when using a portable circular saw?
   a. Combination square
   b. Try square
   c. Framing square
   d. Rafter angle square

SECTION THREE

3.0.0 CUTTING AND SHAPING TOOLS

Objective

Identify and explain how to use various types of cutting and shaping tools.

a. Identify and explain how to use handsaws.
b. Identify and explain how to use various types of files and utility knives.

Performance Tasks

1. Visually inspect the following tools to determine if they are safe to use:
   - Hand saw
   - File
   - Utility knife
2. Safely and properly use the following tools:
   - File
   - Utility knife
3. Make a straight, square cut in framing lumber using a crosscut saw.

Trade Terms

Kerf: A cut or channel made by a saw.

Miter joint: A joint made by fastening together usually perpendicular parts with the ends cut at an angle.

Tang: Metal handle-end of a file. The tang fits into a wooden or plastic file handle.

Tenon: A piece that projects out of wood or another material for the purpose of being placed into a hole or groove to form a joint.

There are many different saws on the market. Some have specific purposes, while others can be used for multiple tasks. From logging saws to hacksaws, saws have been used for the past 5,000 years.

3.1.0 Saws

Using the right saw for the job makes cutting easy. The main differences between types of saws are the shape, number, and pitch of their teeth. These differences make it possible to cut straight or curved lines through wood, metal, plastic, or wallboard. As a general rule, the fewer points, or teeth per inch (tpi), on a saw blade, the coarser and faster the cut will be; the more teeth, the slower and smoother the cut will be.

Figure 38 shows several types of saws. The following are brief descriptions of these saws.

WARNING! Saw teeth are very sharp. Use gloves and do not handle the saw teeth with bare hands. When cutting with a saw, ensure that your fingers remain clear of the teeth at all times.

- *Backsaw* – The standard blade of this saw is 8" to 14" long (20 cm to 36 cm) with 11 to 14 tpi. A backsaw has a broad, flat blade and a reinforced back edge. It is used for cutting joints, especially **miter joints** and **tenons**. The reinforced back keeps the blade straight and true.
- *Keyhole saw* – The standard blade of this saw is 12" to 14" (30 cm to 36 cm) long with 7 or 8 tpi. This saw cuts curves quickly in wood, plywood, or wallboard. It is also used to cut holes for large-diameter pipes, vents, and plugs or switch boxes.
- *Coping saw* – This saw has a narrow, flexible blade attached to a U-shaped frame. Holders at each end of the frame can be rotated so you can cut at an angle to the frame. They also adjust to maintain proper blade tension. Standard blades range from 10 to 20 tpi. The coping saw is used for making irregular-shaped moldings fit together cleanly. As a general rule, coping saw blades are mounted with the teeth pointing towards the handle, making it cut on the pull stroke. However, not all woodworkers agree, and the blade can be placed in the opposite direction, for cutting on the push stroke, if the situation calls for it.
- *Drywall saw* – A drywall saw is a long, narrow saw used to cut softer building materials, such as drywall. Drywall saws can have a fixed blade or a retractable blade held to either a wood or plastic handle with thumb screws. The blade on a drywall saw has a very sharp point to easily poke a hole to start a cut without drilling a starter hole. The jigsaw and spiral saw are power tools that are sometimes used in the same applications as a drywall saw.
- *Handsaw* – The standard blade of this saw is 26" long with 8 to 14 tpi for a crosscut saw and 5 to 9 tpi for a ripsaw. A crosscut saw, as the name implies, is designed to cut wood across the grain. A ripsaw is designed to cut wood in the same direction as the grain.
- *Hacksaw* – The standard blade of this saw is 8" to 16" (20 cm to 41 cm) long with 14 to 32 tpi. It has a sturdy frame and a pistol-grip handle.

Figure 38 Types of saws.

The blade is tightened using a wing nut and bolt. The hacksaw is used to cut through metal such as nails, bolts, or pipe. When installing a hacksaw blade, be sure that the teeth face away from, not toward, the saw handle. Hacksaws are designed to cut on the push stroke, not on the pull stroke.

3.1.1 Handsaws

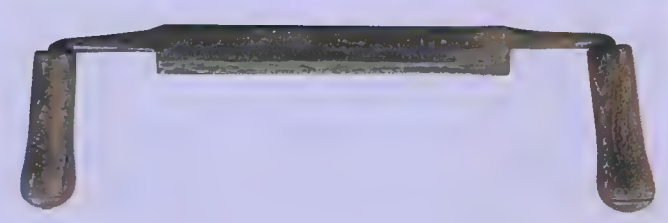
The handsaw's blade is made of tempered steel so it will stay sharp and will not bend or buckle. Handsaws are classified mainly by the number, shape, size, slant, and direction of the teeth. Saw teeth are set or angled alternately in opposite directions to make a cut (or **kerf**) slightly wider than the thickness of the saw blade itself. Two common types of handsaws are the crosscut saw and the ripsaw. However, there are many variations today in blade design that make some versions more universal in their use.

The crosscut saw, which has 8 to 14 tpi, is designed to cut across the grain of wood, cutting slower but smoother than a ripsaw. Blade lengths

Did You Know?

The Romans and Their Tools

Ancient Egyptians and Greeks used a variety of tools. The Romans, however, are known as the toolmakers of the ancient world. The plane, metal-cutting saw, drawknife, frame saw, level, square, and claw hammer were all created by the Romans.



range from 20" to 28" (51 cm to 71 cm). For most general uses, 24" or 26" (61 cm or 66 cm) is a good length.

Follow these steps to use a crosscut saw properly:

Step 1 Mark the cut to be made with a square or other measuring tool. Also place an X or similar mark on one side of the squared line to show on which side of the line the cut should be made.

Step 2 Make sure the piece to be cut is well-supported on a sawhorse, jack, or other support. Clamp or otherwise secure the material. Support the scrap end as well as the main part of the wood to keep it from splitting as the kerf nears the edge. With short pieces of wood, you can support the scrap end of the piece with your free hand. With longer pieces, you will need additional support or assistance.

Step 3 Don work gloves before beginning. Place the saw teeth on the edge of the wood farthest from you, just at the outside edge of the mark. Note that the edge of the blade should be aligned with the line on the waste side of the lumber.

Step 2 Start the cut with the part of the blade closest to the handle end of the saw, pulling the first stroke toward your body.

Step 4 Use the thumb of the hand that is not sawing to guide the saw so it stays vertical to the work.

Step 5 Place the saw at about a 45-degree angle to the wood and pull the saw to make a small groove.

Step 6 Start sawing slowly, increasing the length of the stroke as the kerf deepens. Remember that the cutting is done on the push stroke. Therefore, the push stroke is often a bit more forceful and faster than the pull stroke.

Step 7 Do not push or ride the saw into the wood. Let the weight of the saw set the cutting rate. This will make it easier to control the saw and is less tiring.

Step 8 Continue to saw with the blade at a 45-degree angle to the wood. If the saw starts to wander from the line, angle the blade back toward it. If the saw blade sticks in the kerf, wedge a thin piece of wood into the cut to hold it open.

The ripsaw has 5 to 9 tpi, and is designed to cut with the grain (parallel to the wood fibers), meeting less resistance than a crosscut saw. Because it has fewer teeth than the crosscut saw, it will make a coarser, but faster cut. To use a ripsaw properly, mark and start a ripping cut the same way you would start cutting with a crosscut saw (*Figure 39*). Once you've started the kerf, saw with the blade at a steeper, 60-degree angle to the wood.

3.1.2 Safety and Maintenance

Saws must be maintained for them to work safely and properly. Also, it is very important to focus on the work when sawing—saws can be dangerous if used incorrectly or if you are not paying attention. Here are the guidelines for working with handsaws:

- Brace yourself when sawing so you are not thrown off balance on the last stroke.
- Clamp or otherwise secure the workpiece to prevent it from moving while sawing.
- Clean your saw blade with a fine emery cloth and apply a coat of silicone lubricant if it starts to rust.
- Always lay a saw down gently.
- Have saws sharpened by an experienced sharpener.
- Do not let saw teeth come in contact with stone, concrete, or metal.

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Figure 39 Kerf cut across the wood grain.

3.2.0 Files and Utility Knives

Files and rasps are shaping tools that can be used in areas that chisels cannot reach. They are commonly used to remove wood and metal burrs and smooth rough spots to either finish a surface or prepare it for the next step.

As the name implies, the utility knife is used as a general purpose tool. It is not designed for one particular use. Because of its versatility, utility knives are now quite common among all trades.

WARNING!

All types of files and utility knives have sharp points and edges that can cause serious injury. Handle knives and files with extreme caution and the greatest of care. Never use a file without first installing a handle.

3.2.1 Files and Rasps

Files and rasps are used to cut, smooth, or shape metal and wood parts. A variety of files are shown in *Figure 40*.

Files have slanting rows of teeth, while rasps have individual teeth which are more aggressive (deeper). Rasps are designed primarily for use on wood, and files are used on metal. Files and rasps are usually made from a hardened piece of high-grade steel. They are sized by the length of the body (*Figure 41*). The size does not include the handle because the handle is generally separate from the file or rasp. The sharp metal point at the end of the file, the **tang**, fits into the handle. Handles can easily be transferred from one file to another. For most sharpening jobs, files and rasps range from 4" to 14" (20 cm to 36 cm) in length.

Choose a file or rasp with a shape that fits the area to be filed. Files are available in round, square, flat, half-round, and triangular shapes (*Figure 42*). For filing large concave (curved inward) or flat surfaces, a half-round shape is used.

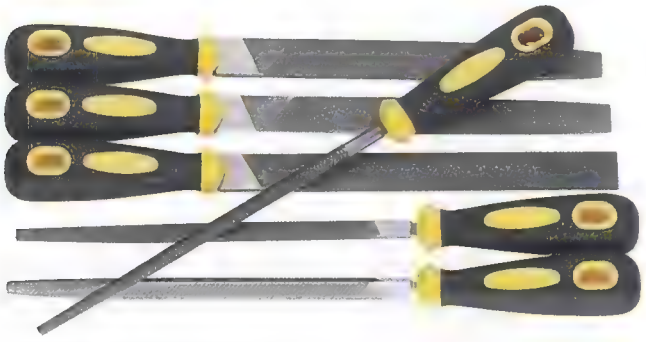

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Figure 40 Files with handles.

Did You Know?

Emery Cloth

Emery cloth is a maintenance and cleaning tool often used in the construction industry. It is normally used for cleaning tools made of metal, such as handsaws. It may be used wet or dry in a manner very similar to sandpaper. Emery cloth is coated with a substance called powdered emery, which is a granular form of pure carborundum. After using an emery cloth, always be sure to use a silicone lubricant on the tool to prevent rusting.

For filing small curves or for enlarging and smoothing holes, a round shape with a tapered end is used. For filing angles, a triangular file is used.

There is a specific type of file for each of the common soft metals, hard metals, plastics, and wood. In general, the teeth of files for soft materials are very sharp and widely spaced. Those for hard materials are less sharp and closer together. The shape of the teeth also varies depending on the material to be worked. Using a file designed for soft material on hard material will quickly chip and dull the teeth; whereas using a file designed for hard material on soft material will clog the teeth.

File classifications include single-cut, with all rows of teeth facing the same direction; and double-cut, with rows of teeth crisscrossing each other, forming a diamond pattern. Files are also classified according to their texture and depth of teeth. These include rough, coarse, bastard, second cut or medium, and smooth. Obviously, smoother files apply a smoother finish. Smooth files have more cuts per inch across the face, and the cuts are shallow. Bastard files are relatively coarse models, classified just below coarse files. The unusual name *bastard file* stems from the fact that it is an irregularity in the file line-up. Coarse files have fewer, deeper cuts (teeth) per inch. Rasps are also classified by the nature of their teeth: coarse, medium, and fine. *Table 1* lists types of files and some uses for each.

Trying to use a file the wrong way is inefficient and can be frustrating. Follow these steps to use a file properly:

Step 1 Wear work gloves. Ensure the file handle is securely tightened.

Step 2 Mount the work to be filed in a vise at approximately elbow height.

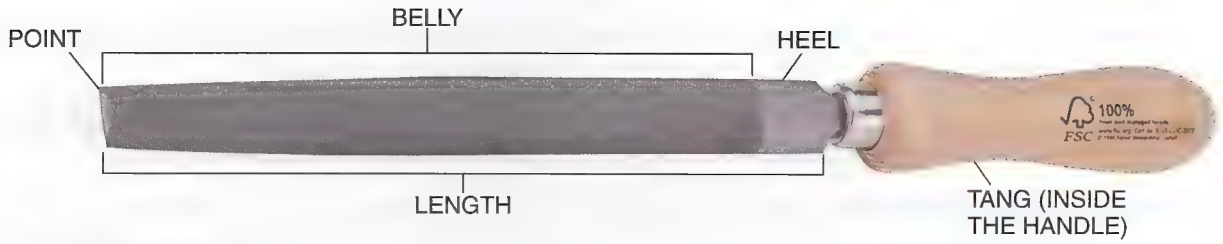

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Figure 41 Parts of a file.

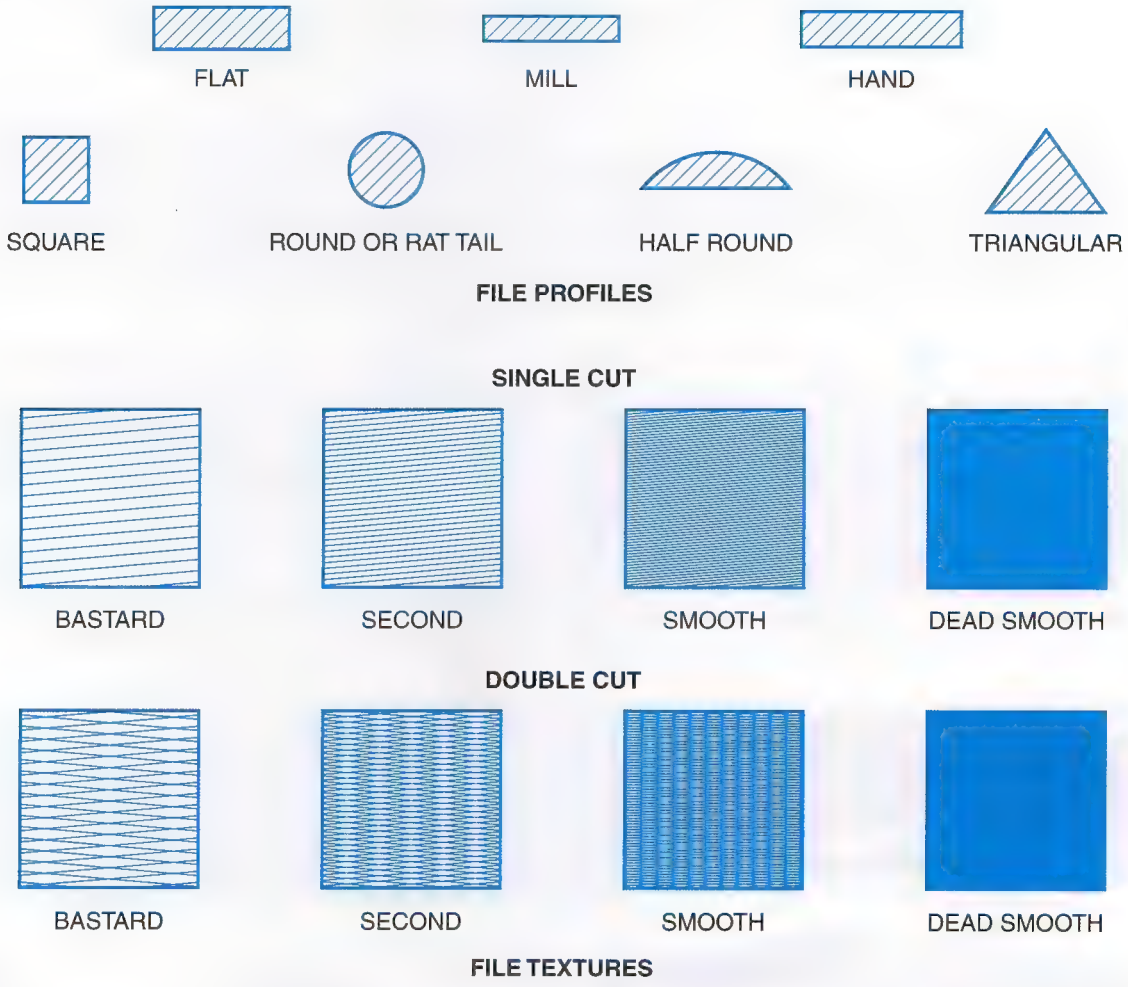

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Figure 42 File profiles and textures.

Step 3 Do not lean directly over the work. Stand back from the vise with feet approximately 24" (61 cm) apart, with the right foot ahead of the left. (If left-handed, the left foot will be ahead of the right.)

Step 4 Hold the file handle with one hand and steady the tip of the blade with the other hand.

Step 5 For average work, hold the tip with your thumb on top of the blade and the first two fingers under it. For heavy work, use a full-hand grip on the tip.

Step 6 Apply pressure only on the forward stroke. The file cuts on the push stroke. Placing pressure on the file during the back stroke while the file remains in contact with the workpiece only wears out the file.

Step 7 Raise the file from the work on the back stroke to prepare for the next stroke.

Step 8 Keep the file flat on the work.

Table 1 Types and Uses of Files

Type	Description	Uses
Rasp-cut file	The teeth are individually cut; they are not connected to each other.	Leaves a very rough surface. Can be used on soft metal, but is primarily used on wood.
Single-cut file	Has a single set of straight-edged teeth running across the file at an angle.	Used to sharpen edges, such as rotary mower blades.
Double-cut file	Two sets of teeth crisscross each other. Types are bastard (roughest cut), second cut, and smooth.	Used for fast cutting and material removal.

3.2.2 Utility Knives

A utility knife (*Figure 43*) is used to cut a variety of materials including roofing felt, fiberglass or asphalt shingles, vinyl or linoleum floor tiles, fiberboard, and gypsum board. Utility knives can also be used for trimming insulation and opening cartons.

The utility knife has a replaceable razor-like blade. The handle, which is approximately 6" (15 cm) long and is made of die-cast metal or plastic, holds the blade. The least expensive, simpler models are made in two halves, held together with a screw for blade replacement. Other models, such as the ones shown in *Figure 43*, fold to a more compact size. For increased safety, some utility knives self-retract the blade when thumb pressure is taken off the blade control. Note that some job sites or employers may require the use of self-retracting knives to maximize safety. Note the different blade used in the carpet knife in *Figure 43*. Carpet is highly abrasive and hard on blades. Carpet knife blades have two sharpened edges, so they can be reversed to extend their usable life.

As with any sharp tool, it is important to wear the appropriate gloves (such as those made from Kevlar®) for protection against injury (*Figure 44*). Note that Kevlar® materials are reported to have five times the strength of steel at equal weights.

WARNING! Utility knife blades are extremely sharp, having a razor edge.

To use a retractable-blade utility knife safely and properly, place a protective barrier, such as a piece of wood, under the object to be cut. Always wear gloves. Unlock and push the blade out by pushing on the lever and sliding it outwards.

Figure 43 Utility knives.

Figure 44 Kevlar® gloves.

Release pressure on the lever to lock the blade. Always cut away from the body, or perpendicular to it. Once cutting is complete, unlock and pull the blade in by pushing on the lever and sliding it inwards. Folding models have a blade lock that must be depressed to fold and unfold.

3.2.3 Safety and Maintenance

Files and rasps will become worthless without proper maintenance. Here are some guidelines for the use and maintenance of files and rasps:

- Use the correct file for the material being worked.
- Always put a handle on a file before using it; files and rasps often come without handles when boxed.
- After using a file, brush the filings from between the teeth using a file card or wire brush, pushing in the same direction as the alignment of the teeth. A file card has tightly spaced, short, stiff wires on its face that can dislodge material from between the file teeth.
- Store files in a dry place and keep them separated so that they won't chip or damage each other.
- Do not let the material vibrate in the vise as you file, because it dulls the teeth and produces an irregular surface on the workpiece.

Here are some guidelines for safely using and maintaining a utility knife:

- Replace blades when they stop cutting and start tearing. Sharp blades are safer than dull ones.
- Always keep the blade closed and locked when a utility knife is not in use.
- Be sure to position yourself properly and make the cut in the appropriate direction, keeping your free hand out of the line of the cut. Cut perpendicular to the body (left-to-right or right-to-left) or away from the body.
- Do not apply side loads to the blade, such as trying to pry open a can lid. The brittle blades can easily snap off.

Additional Resources

Easy Ergonomics: A Guide to Selecting Non-Powered Hand Tools. National Institute for Occupational Safety and Health (NIOSH), DHHS Publication No. 2004-164. **www.cdc.gov**

Field Guide to Tools. John Kelsey. 2004. Philadelphis, PA: Quirk Books.

3.0.0 Section Review

1. A coping saw is used for cutting ____.
   a. joints
   b. nails
   c. steel plate
   d. irregularly shaped moldings

2. Which of the following file types would apply the smoothest finish?
   a. Bastard
   b. Coarse
   c. Second-cut
   d. Rasp

SECTION FOUR

4.0.0 OTHER COMMON HAND TOOLS

Objective

Identify and explain how to use other common hand tools.

a. Identify and explain how to use shovels and picks.
b. Identify and explain how to use chain falls and come-alongs.
c. Identify and explain how to use various types of clamps.

Performance Tasks

1. Visually inspect the following tools to determine if they are safe to use:
   - Shovel or other earth tool
   - Chain fall or hoist
   - Clamps
2. Safely and properly use the following tools:
   - Shovel or other earth tool
   - Chain fall or hoist
   - Clamps

The proper selection and safe use of shovels, picks, chain falls, come-alongs, and clamps is discussed in this section. Proper training to use these tools is especially important because improper use could easily cause injuries such as back strains, as well as falling loads and material slippage.

4.1.0 Shovels and Picks

Shovels are used by many different construction trades. An electrician running underground wiring may dig a trench. A concrete mason may dig footers for a foundation. A carpenter may clear dirt from an area for concrete form-building. A plumber may dig a ditch to lay pipe. A welder may use a shovel to clean up scrap metal and slag after a job is finished.

There are three basic shapes of shovel blades: round, square, and spade (*Figure 45*). A round-bladed shovel is used to dig holes or remove large amounts of soil. A square-bladed shovel is used to move gravel or clean up construction debris. A spade is used to move large amounts of soil or dig trenches that need smooth, straight sides.

Figure 45 Shapes of shovel blades.

Shovels can have wooden or fiberglass handles. They generally come in two lengths. A long handle is usually 47" to 48" (1.2 m) long; a short handle is usually 27" (66 cm) long. Short handles often have a D-ring on the end to provide a different grip. Generally, the longer handles provide better leverage, but a shovel is not meant to be used as a lever. Roots and other obstructions should be cleared with other tools.

The first step to using any shovel is to select the right type for the job. For a round shovel or spade, place the tip of the shovel blade or spade at the point where digging or soil removal will begin. Balance a foot on the turned step and press down to cut into the soil with the blade.

For a square shovel, place the leading edge of the shovel blade against the gravel or construction debris and push until the shovel is loaded.

A pick is a swinging tool similar to an ax (*Figure 46*). A pick consists of a wooden handle that is 36" to 45" (91 cm to 1.1 m) in length and a forged steel head weighing 2 to 3 pounds (907 g and 1 kg). Depending on the size and strength of the pick, it can be used to break hardened or rocky soil, to level out stones and pavers, to loosen soil, and to break up stones and concrete. Long-handled picks (45" or 1.1 m) are used for tasks that require a normal amount of swing force, such as that used for digging a hole. Short-handled picks are used when a maximum amount of swinging

Figure 46 Pick and mattock.

force is required and when the target is in a depression. The worker may use a short-handled pick while kneeling in these situations.

Very similar to a pick, a mattock is also used for breaking hardened, rocky soil and to dig trenches. Mattocks are much better than picks for clearing tree roots, due to the wide blade. The mattock may have a slightly shorter wooden handle than a pick. One side of the mattock head has a wide cutting blade, as shown in *Figure 46*. The other end may be like a pick, or (as shown) another blade turned 90 degrees from the mattock blade.

The first step to using a pick or mattock safely and correctly is to select the pick appropriate for your height and strength. Gloves should always be worn, as well as steel-toe work boots or shoes. Place one hand at the end of the handle and with the dominant hand about two-thirds of the way up the handle. For tasks using a short-handled pick to strike hard, raise the pick up and over the head like an axe, rapidly bending the knees and back to plunge the tool into the ground. For tasks requiring less forceful strikes, use a long-handled pick. Raise the pick up to chest height and then swing it back toward the ground, using the weight of the tool head and the leverage of the long handle to produce the strike.

4.1.1 Safety and Maintenance

Here are some guidelines for working safely with shovels:

- Always check to ensure that the blade is fixed firmly to the handle and no cracks or splits are present.
- Use the appropriate PPE when digging, trenching, or clearing debris, including safety glasses and gloves. Wear hard-toed boots to protect your feet from dropped materials and tool blades.
- Don't let dirt or debris build up on the blade. Always rinse off the shovel blade after using it.

Here are some guidelines for working safely with picks:

- Always check to ensure that the head is fixed firmly to the handle and no cracks or splits are present in the handle.
- Make sure that there are no other workers in the swing path before beginning the work.
- Always use a pick that is of the appropriate length and weight for your size.
- Only use maximum force swings (over your head) when necessary, because they put more strain on your back and shoulders than do normal swings (chest height).
- Be sure to wear appropriate eye protection, gloves, and steel-toe shoes.

4.2.0 Chain Falls and Come-Alongs

Chain falls and come-alongs are used to move heavy loads safely. A chain fall, also called a chain block or chain hoist, is a tackle device fitted with an endless chain used for hoisting heavy loads by hand. It is usually suspended from an overhead track. A come-along is used to move loads horizontally over the ground for short distances.

4.2.1 Chain Falls

The chain fall (*Figure 47*) has an automatic brake that holds the load after it is lifted. As the load is lifted, a screw forces fiber discs together to keep the load from slipping. The brake pressure increases as the loads get heavier, and the brake holds the load until the lowering chain is pulled. Manual chain falls are operated by hand. Electrical chain falls are operated from a tethered or wireless electrical control box.

The suspension hook is a steel hook used to hang the chain fall. It is often one size larger than the load hook. The gear box contains the gears that provide lifting power. The hand chain is a continuous chain used to operate the gearbox. The load chain is attached to the load hook and used to lift loads. A safety latch prevents the load from slipping off the load hook, which must be securely attached to the load.

Figure 47 Parts of a chain fall.

4.2.2 Come-Alongs and Ratchet Chain Hoists

Come-alongs and ratchet chain hoists use a ratcheting handle to position or move loads horizontally (*Figure 48*). They can generally move loads from 1 to 6 tons. Ratchet chain hoists may be used for vertical lifting if they are designed and rated for the task. Cable come-alongs should not be used for vertical lifting, as they typically do not have a locking mechanism that is considered safe enough to lift a load vertically.

WARNING!

Never use a cable come-along for vertical overhead lifting. Use this tool only to move loads horizontally for short distances. Cable come-alongs are not equipped with the necessary safety features to ensure the safety of the load and nearby workers. For vertical lifting, use a chain fall or chain come-along designed and rated for lifting purposes.

4.2.3 Safety and Maintenance

Guidelines for maintaining and safely using chain falls and come-alongs include the following:

Figure 48 Come-along and ratchet chain hoist.

- Follow the manufacturer's recommendations for lubricating the chain fall or come-along.
- Inspect a chain fall or come-along for wear before each use.
- Try out a chain fall or come-along on a small load first to ensure it is working normally.
- Have a qualified person ensure that the support rigging is strong enough to handle the load.
- Do not get lubricant on the clutches.
- Never stand under a load or allow others to do so.
- Never put hands your near pinch-points on the chain.

4.3.0 Clamps

There are many types and sizes of clamps (*Figure 49*), each designed to satisfy a different holding requirement. Clamps are sized by the maximum opening of the jaw. The depth (or throat) of the clamp determines how far from the edge of the work the clamp can be placed. The following are common types of clamps:

- *C-clamp* – This multipurpose clamp is named for its C-shaped frame. The clamp has a metal shoe at the end of a screw. Using a sliding T-bar handle, the clamp is tightened so it holds material between the metal jaw of the frame and the shoe. C-clamps are strong and durable, providing great holding power.
- *Locking C-clamp pliers* – This clamp works just like locking pliers. A knob in the handle controls the width and tension of the jaws. The handles are closed to lock the clamp and a lever is pressed to unlock and open the jaws.
- *Spring clamp* – Use a hand to open the spring-operated clamp. When the handles are released, the spring holds the clamp tightly shut, applying even pressure to the material. The jaws are usually made of steel, some with plastic coating to protect the material's surface against scarring.

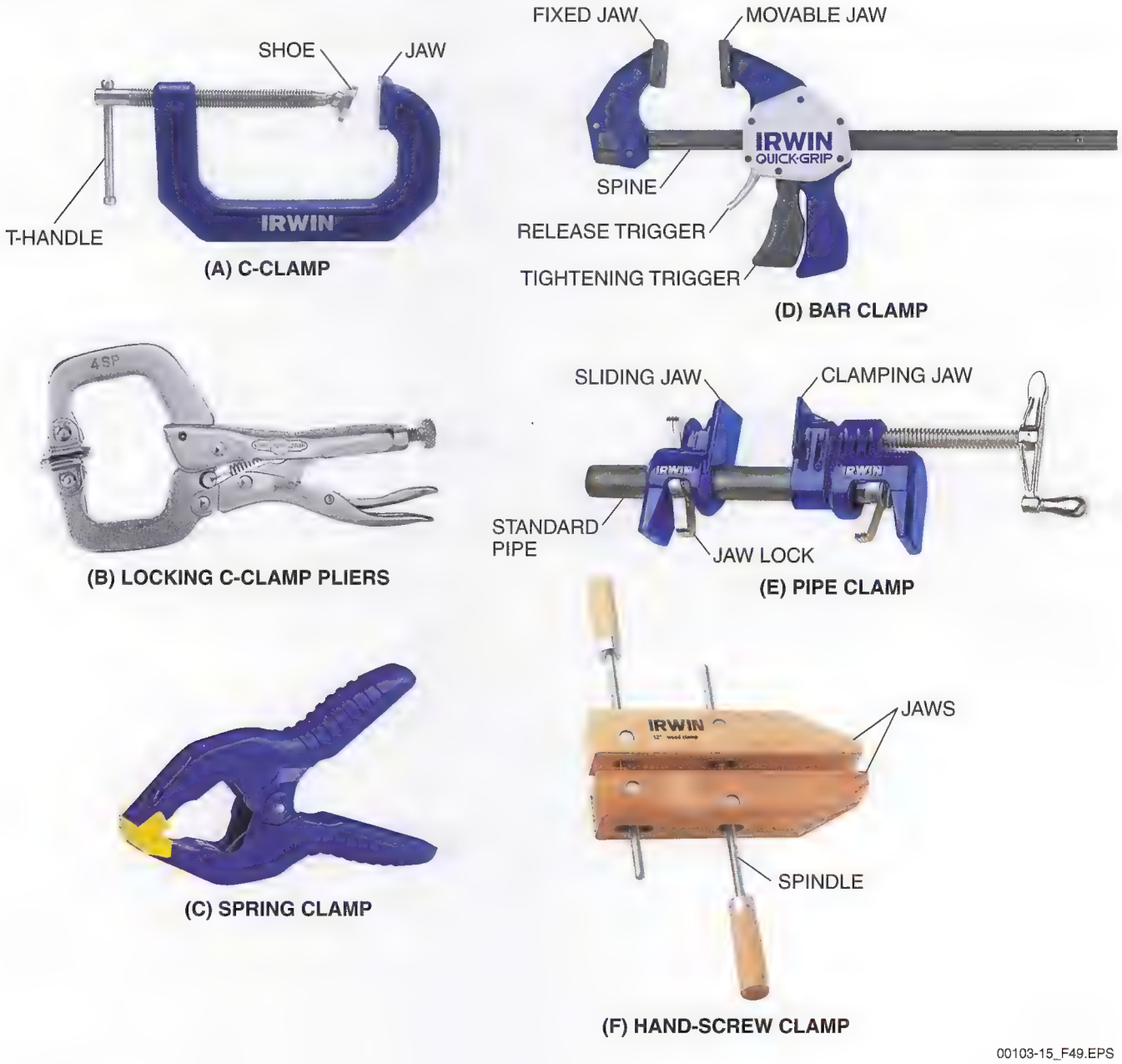

Figure 49 Types of clamps.

- *Bar clamp* – A rectangular piece of steel or aluminum is the spine of the bar clamp. It has a fixed jaw at one end and a sliding jaw (tail slide) with a spring-locking device that moves along the bar. It is equipped with non-marring pads that prevent it from damaging delicate surfaces such as finished woods. It is also designed to release the material quickly and easily without an explosive pressure release simply by squeezing the release trigger. Another feature of this tool is that you can quickly and easily change the direction of the jaw to turn it into a spreader bar. Simpler bar clamps are built more like pipe clamps, as described below.
- *Pipe clamp* – Although this clamp looks like a bar clamp, the spine is actually a length of pipe. It has a fixed jaw and a movable jaw that work the same way as the bar clamp. The movable jaw has a lever mechanism that is squeezed when sliding the movable jaw along the spine. The pipe connecting the two jaw assemblies can be any length required; even a full length of pipe can be used if necessary. The pipe clamp is popular for large or wide clamping tasks as a result.
- *Hand-screw clamp* – This clamp has wooden jaws. It can spread pressure over a wider area than other clamps can. Each jaw works independently. The jaws can be angled toward or away from each other or be kept parallel. The clamp is tightened by using the spindles that screw through the jaws.
- *Web (strap, band) clamp* – This clamp (*Figure 50*) uses a belt-like canvas or nylon strap or band to apply even pressure around a bundle of material or similar applications. After looping the band around the work, the clamp head is used to tighten the band with a ratcheting action. A quick-release device loosens the band when finished.

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Figure 50 Web clamp.

When clamping wood or other soft material, place rubber pads or thin blocks of wood between the workpiece and the clamp to protect the work, as shown in *Figure 51*. Tighten the clamp's pressure mechanism (such as the T-bar handle shown here), but do not force it.

4.3.1 Safety and Maintenance

The following are guidelines for using clamps:

- Store clamps by lightly clamping them to a rack.
- Use pads or thin wood blocks when clamping wood or other soft materials.
- Discard clamps with bent frames.
- Clean and oil threads.
- Check the shoe at the end of the screw to make sure it turns freely.
- Never use a clamp for hoisting work.
- Do not use pliers or pipe on the handle of a clamp for tightening.
- Do not overtighten clamps.

CAUTION

When tightening a clamp, do not use pliers or a section of pipe on the handle to extend your grip or gain more leverage. Doing so means you will have less control over the clamp's tightening mechanism.

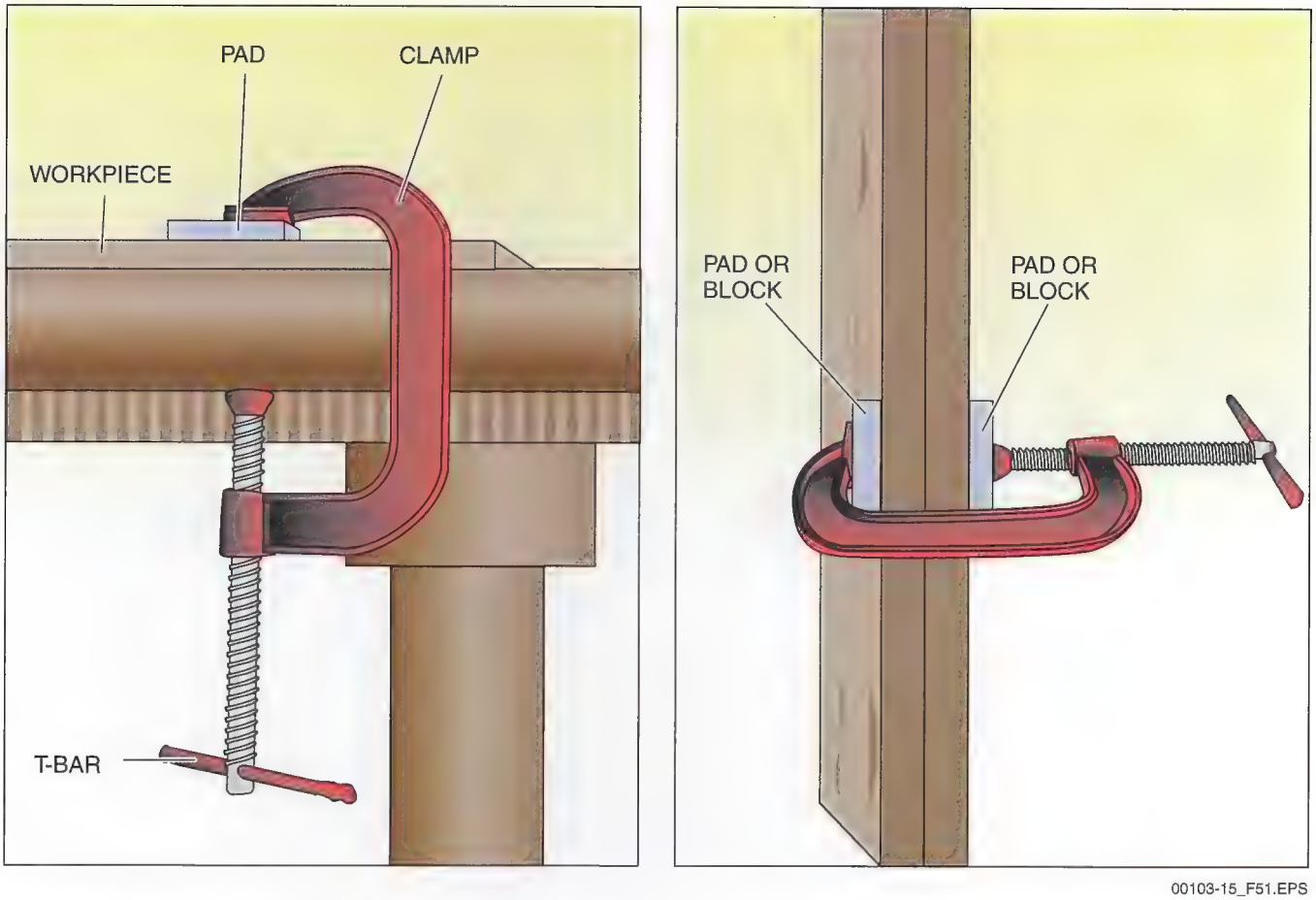

Figure 51 Placing pads and wood blocks.

Additional Resources

Easy Ergonomics: A Guide to Selecting Non-Powered Hand Tools. National Institute for Occupational Safety and Health (NIOSH), DHHS Publication No. 2004-164. **www.cdc.gov**

Field Guide to Tools. John Kelsey. 2004. Philadelphia, PA: Quirk Books.

4.0.0 Section Review

1. What makes a mattock different from a pick?
   a. There is a wide blade on one end of a mattock.
   b. There is a wide blade on one end of a pick.
   c. A mattock is used only in rock.
   d. A pick has a sledgehammer on one end.

2. Another name for a cable puller is ____.
   a. come-along
   b. ratchet
   c. chain fall
   d. chain block

3. Which type of clamp is best suited for a very wide clamping application, such as 8 feet?
   a. C-clamp
   b. Bar clamp
   c. Spring clamp
   d. Pipe clamp

SUMMARY

As a craft professional, your hand tools are an essential ingredient for success. In this module, you learned to identify and work with many of the basic hand tools commonly used in construction. Although you may not work with all of the tools introduced in this module, you will use many of them as you progress in your career, regardless of what craft area you choose.

When you use hand tools properly, you are working safely and efficiently. You are not only preventing accidents that can cause injuries and equipment damage, you are showing your employer that you are a responsible, safe worker.

The same pride you take in using your tools to do a job well is important when it comes to maintaining your tools. When you maintain your tools properly, they last longer, work better, and function more safely. The simple act of maintaining your tools will also help you perform your job better. Taking the time to learn to use and maintain these tools properly now will help keep you safe and save you time and money down the road.

Review Questions

1. The safest hammers are those with heads that are _____.
   a. welded and alloyed
   b. cast steel and chiseled
   c. chiseled and drop forged
   d. alloy and drop-forged steel

2. A chisel bar can be used to _____.
   a. pry apart steel beams
   b. split and rip apart pieces of wood
   c. break apart concrete
   d. make channels in wood beams

3. Paring chisels are _____.
   a. longer and much wider than other wood chisels
   b. much heavier than other wood chisels
   c. much shorter than other wood chisels
   d. longer and thinner than other wood chisels

4. For safety's sake, industrial screwdriver blades are made of _____.
   a. tempered steel
   b. Torx®
   c. clutch-driven steel
   d. fiberglass

5. An adjustable wrench is a good working partner to _____.
   a. pliers
   b. screwdrivers
   c. non-adjustable wrenches
   d. hammers

6. What type of mechanism do socket wrenches use?
   a. Clutch
   b. Chain
   c. Ratcheting
   d. Universal

7. The longer the ratchet handle, the better the _____.
   a. reach
   b. leverage
   c. gripe
   d. torque

8. The type of torque wrench designed for tightening clamping bands on underground pipe is the _____.
   a. digital type
   b. click type
   c. jointed type
   d. no-hub type

9. Torque wrenches are used to determine how much torque is required to loosen a rusted bolt.
   a. True
   b. False

10. Pliers should *not* be used on a nut or bolt because _____.
    a. they will round off the edges of the hex head
    b. they are not strong enough
    c. they are designed only for tightening
    d. their jaws will not open wide enough

11. What type of pliers could be used for cutting heavy duty wire?
    a. Slip-joint
    b. Locking
    c. Lineman
    d. Tongue-and–groove

12. An advantage of a laser measuring tool is that it _____.
    a. can be stored in your toolbox without breaking
    b. can take longer measurements
    c. has a large accuracy window
    d. is cheap to purchase

13. In order to determine whether a surface is level, check the _____.
    a. vertical surface
    b. spirit
    c. horizontal surface
    d. amount of bubbles

14. When something is plumb, it is _____.
    a. exactly vertical
    b. horizontally level
    c. at a 30-degree angle
    d. bobbed

15. The try square is made at a fixed _____.
    a. 45-degree angle
    b. 90-degree angle
    c. 180-degree angle
    d. 360-degree angle

16. Files have slanting rows of teeth and the teeth on a rasp are _____.
    a. smooth
    b. individual
    c. coarse
    d. wire

17. How is a carpet knife different from a common utility knife?
    a. The blade has a single sharpened edge.
    b. The blade has two sharpened edges.
    c. A carpet knife is much longer.
    d. A carpet knife uses a round, spinning blade.

18. A spade is used to _____.
    a. clear tree roots
    b. move gravel or clean up construction debris
    c. tamp down soil along a building's foundation
    d. move large amounts of soil or dig trenches with straight sides

19. Chain falls are used to _____.
    a. transport light loads safely
    b. supplement come-along pulls
    c. rig light loads safely
    d. safely move heavy loads vertically

20. A hand-screw clamp has _____.
    a. metal jaws
    b. nylon jaws
    c. wooden jaws
    d. fiberglass jaws

Trade Terms Quiz

Fill in the blank with the correct term that you learned from your study of this module.

1. Used mainly for woodworking, the _____ is set at a fixed, 90-degree angle.
2. A(n) _____ is an L-shaped, hexagonal steel bar.
3. The _____ has a flat face for striking and a rounded face for rounding off metal and rivets.
4. Shaped like an L, the _____ is used to make sure wall studs and sole plates are at right angles to each other.
5. A(n) _____ is a metal tool with a sharpened, beveled edge that is used to cut and shape wood, stone, or metal.
6. The _____ is used to drive nails and to pull nails out of wood.
7. To _____ is to cut on a slant at an angle that is not a right angle.
8. The _____ has a 12" blade that moves through a head that is constructed with both 45-degree and 90-degree angles.
9. If you use a screwdriver incorrectly, you can damage the screwdriver or _____ the screw head.
10. A(n) _____ has a moveable jaw that allows it to adjust to different nut or bolt sizes.
11. To fasten or align two pieces or material, you can use a(n) _____, which is a pin that fits into a corresponding hole.
12. A(n) _____ is a device such as a nut or bolt used to attach one material to another.
13. Use a(n) _____ for heavy-duty dismantling of woodwork.
14. The straight sides or jaws of a wrench opening are called the _____.
15. A(n) _____ is a claw hammer with a slightly rounded face.
16. _____ is a unit of measure used to describe the torque needed to tighten a large object.
17. _____ is a unit of measure used to describe the torque needed to tighten a small object.
18. The point at which members or the edges of members are joined is called the _____.
19. The _____ is the cut or channel made by a saw.
20. Using a(n) _____ can speed up your work because it has an open wrench at one end and a box-end at the other.
21. Use a(n) _____ to determine if a surface is exactly horizontal.
22. You make a(n) _____ by fastening together usually perpendicular parts with the ends cut at an angle.
23. A(n) _____ is a tool used to remove nails.
24. A(n) _____ has a fixed opening at each end that allows it to fit more than one size of nut or bolt.
25. To reduce stress in a weld, use a special type of hammer for _____ the joint as it cools.
26. Used for marking, checking, and measuring, a(n) _____ comes in several types: carpenter's, rafter angle, try, and combination.
27. A(n) _____ has serrated teeth on both jaws for gripping power.
28. _____ is the rotating or turning force applied to an object such as a bolt or nut.
29. The _____ is used to pull nails that have been driven flush with the surface of the wood or slightly below it.
30. A box-end wrench has 6 or 12 _____.
31. The _____, a non-adjustable wrench, forms a continuous circle around the head of a fastener.
32. To indent metal before you drill a hole, to drive pins, or to align holes in two parts that are mates, use a(n) _____.

33. Also called a speed square or magic square, the _____ is a combination protractor, try square, and framing square.
34. Using a damaged screwdriver on a screw may _____ the head and make the screw difficult to remove.
35. The _____ is a tool with a claw at each end, commonly used to pull nails.
36. A special type of adjustable wrench, _____ are scissor-shaped tools with jaws.
37. The _____ fits into a wooden file handle.
38. Some tools are made of _____ steel so that they resist wear and do not bend or break.
39. A(n) _____ piece of lumber is one that has had its surface made smooth.
40. If a surface is _____, it is exactly vertical.
41. A(n) _____ is a piece that projects out of wood so it can be placed into a hole or groove to form a joint.
42. A(n) _____ is a joint that has been created by heating pieces of metal.
43. A(n) _____ is a non-adjustable wrench with an enclosed, circular opening designed to lock onto the fastener when the wrench is struck.
44. In the metric system, the unit of measure for torque or moment is the _____.

Trade Terms

Adjustable wrench
Ball-peen hammer
Bell-faced hammer
Bevel
Box-end wrench
Carpenter's square
Cat's paw
Chisel
Chisel bar
Claw hammer
Combination square
Combination wrench
Dowel
Fastener
Flats
Foot-pounds
Hex-key wrench
Inch-pounds
Joint
Kerf
Level
Miter joint
Nail puller
Newton-meter
Open-end wrench
Peening
Pipe wrench
Planed
Pliers
Plumb
Points
Punch
Rafter angle square
Ripping bar
Round off
Square
Striking wrench
Strip
Tang
Tempered
Tenon
Torque
Try square
Weld

Cornerstone of Craftsmanship

Chris Williams

Associated Builders and Contractors, Inc.
Director of Safety

How did you choose a career in the construction industry?
My father owned and operated a light-commercial and residential construction firm, so I was raised in and around construction. I spent many summers on job sites doing every task possible and enjoyed the organization and camaraderie that each crew demonstrated. Continuing in construction after college was a natural progression.

Who inspired you to enter the industry?
My father—witnessing his dedication to not only the industry but also to continuous training and learning to help develop his skills and advance the industry.

What types of training have you completed?
Fall protection competent person, NCCER Master Trainer, and the OSHA 10- and 30-hour courses.

How important is education and training in construction?
Education and training is extremely important, especially from a safety standpoint. Construction safety culture continues to evolve and the concepts—both technical and cultural—need to be reinforced. From a craft standpoint, we can always improve our skills through learning, which enhances our productivity and output.

How important are NCCER credentials to your career?
I would consider NCCER credentials to be of higher value than any others that I have received. Having participated as a Subject Matter Expert and also having gone through the NCCER Master Trainer course, I value the stringent criteria that NCCER holds its students to and the in-depth training materials that are used. In construction, if you're not the very best, you lose business. NCCER helps our members be their very best.

How has training/construction impacted your life?
I grew up in construction so I've witnessed firsthand the value of our industry—and the consequences that a lack of training/understanding can reap. Being involved in construction safety has helped significantly alter my view of how we work—we have evolved from "just get the job done any way you can" to "if you see someone else acting unsafe, it is your job to stop them and help them work safely." The culture of interdependence and the safety training we deliver to our employees is the reason I come to work every day. Construction workers need to know that safety is a core value that affects every other decision made on the job site.

What types of work have you done in your career?
Besides construction safety, I've worked with various construction non-profit associations as both a trainer and consultant.

Tell us about your present job.
I am the Director of Safety for Associated Builders and Contractors, Inc., a merit-shop trade association representing 21,000 chapter members nationwide. I am the point person for our regulatory efforts with OSHA, as well as our safety representative on various bodies. My role over the years has evolved to include the development of new curriculum and training strategies that help advance ABC's safety vision. This vision believes every incident is preventable when leadership is committed to a culture that focuses on safety as a core value, and that every employee is part of the continuing evolution of that culture.

What do you enjoy most about your job?
The interaction with our members and their employees is, by far, the highlight of my job. Being able to visit a job site and see our men and women in action, building and creating—and doing it safely—brings me tremendous pride in being a construction professional.

What factors have contributed most to your success?
A significant contribution is the knowledge and experience of my peers, and their willingness to openly share both their knowledge and safety policies for others to use. Our industry recognizes that the only way to truly protect our employees and reach a zero-incident workplace is by sharing the concepts and ideas with each other. Our industry is truly a team when it comes to construction safety.

Would you suggest construction as a career to others? Why?
Construction is wrongly stigmatized as being the place where people go when they cannot succeed in college. That cannot be further from the truth. In my reality, college is where people go who don't have the creativity, the drive, the passion to succeed in construction! To me, construction is one of the few remaining industries where a man or woman can start a career and, through their own hard work and desire to learn, move up and achieve the American Dream. Construction is the gateway to prosperity if you're willing to seize it.

Interesting career-related fact or accomplishment:
I not only have multiple safety designations, but I'm also a Certified Association Executive (CAE).

How do you define craftsmanship?
Craftsmanship is about the sense of pride and accomplishment in your finished product. It doesn't matter what the project is—a complex electrical system in a refinery or a new light installed in a house—the quality of the finished product is a direct reflection on the quality of your own skills. Satisfaction is found in a sense of pride and in the admiration of your work by others.

Trade Terms Introduced in This Module

Adjustable wrench: A smooth-jawed wrench with an adjustable, moveable jaw used for turning nuts and bolts. Often referred to as a Crescent® wrench due to brand recognition.

Ball-peen hammer: A hammer with a flat face that is used to strike cold chisels and punches. The rounded end—the peen—is used to bend and shape soft metal.

Bell-faced hammer: A claw hammer with a slightly rounded, or convex, face.

Bevel: To cut on a slant at an angle that is not a right angle (90-degree). The angle or inclination of a line or surface that meets another at any angle but 90-degree.

Box-end wrench: A wrench, usually double-ended, that has a closed socket that fits over the head of a bolt.

Carpenter's square: A flat, steel square commonly used in carpentry.

Cat's paw: A straight steel rod with a curved claw at one end that is used to pull nails that have been driven flush with the surface of the wood or slightly below it.

Chisel: A metal tool with a sharpened, beveled edge used to cut and shape wood, stone, or metal.

Chisel bar: A tool with a claw at each end, commonly used to pull nails.

Claw hammer: A hammer with a flat striking face. The other end of the head is curved and divided into two claws to remove nails.

Combination square: An adjustable carpenter's tool consisting of a steel rule that slides through an adjustable head.

Combination wrench: A wrench with an open end and a closed end.

Dowel: A pin, usually round, that fits into a corresponding hole to fasten or align two pieces.

Fastener: A device such as a bolt, clasp, hook, or lock used to attach or secure one material to another.

Flats: The straight sides or jaws of a wrench opening; also, the sides on a nut or bolt head.

Foot-pounds: Unit of measure used to describe the amount of pressure exerted (torque) to tighten a large object.

Hex key wrench: A hexagonal steel bar that is bent to form a right angle. Often referred to as an Allen® wrench.

Inch-pounds: Unit of measure used to describe the amount of pressure exerted (torque) to tighten a small object.

Joint: The point where members or the edges of members are joined. The types of welding joints are butt joint, corner joint, and T-joint.

Kerf: A cut or channel made by a saw.

Level: Perfectly horizontal; completely flat. Also, a tool used to determine if an object is level.

Miter joint: A joint made by fastening together usually perpendicular parts with the ends cut at an angle.

Nail puller: A tool used to remove nails.

Newton-meter: A measure of torque or moment equal to the force of one Newton applied to a lever one meter long.

Open-end wrench: A non-adjustable wrench with a fixed opening at each end that is typically different, allowing it to be used to fit two different nut or bolts sizes.

Peening: The process of bending, shaping, or cutting material by striking it with a tool.

Pipe wrench: A wrench for gripping and turning a pipe or pipe-shaped object; it tightens when turned in one direction.

Planed: Describing a surface made smooth by using a tool called a plane.

Pliers: A scissor-shaped type of adjustable wrench equipped with jaws and teeth to grip objects.

Plumb: Perfectly vertical; the surface is at a right angle (90 degrees) to the horizon or floor and does not bow out at the top or bottom.

Points: Teeth on the gripping part of a wrench. Also refers to the number of teeth per inch on a handsaw.

Punch: A steel tool used to indent metal.

Rafter angle square: A type of carpenter's square made of cast aluminum that combines a protractor, try square, and framing square.

Ripping bar: A tool used for heavy-duty dismantling of woodwork, such as tearing apart building frames or concrete forms.

Round off: To smooth out threads or edges on a screw or nut.

Square: Exactly adjusted; any piece of material sawed or cut to be rectangular with equal dimensions on all sides; a tool used to check angles.

Striking (or slugging) wrench: A non-adjustable wrench with an enclosed, circular opening designed to lock on to the fastener when the wrench is struck.

Strip: To damage the head or threads on a screw, nut, or bolt.

Tang: Metal handle-end of a file. The tang fits into a wooden or plastic file handle.

Tempered: Treated with heat to create or restore hardness in steel.

Tenon: A piece that projects out of wood or another material for the purpose of being placed into a hole or groove to form a joint.

Torque: A rotating or twisting force applied to an object such as a nut, bolt, or screw, using a socket wrench or screwdriver. Torque wrenches allow a specific torque value to be set and applied.

Try square: A square whose legs are fixed at a right angle.

Weld: To heat or fuse two or more pieces of metal so that the finished piece is as strong as the original; a welded joint.

Additional Resources

This module presents thorough resources for task training. The following resource material is suggested for further study.

Easy Ergonomics: A Guide to Selecting Non-Powered Hand Tools. National Institute for Occupational Safety and Health (NIOSH), DHHS Publication No. 2004-164. **www.cdc.gov**

Field Guide to Tools. John Kelsey. 2004. Philadelphia, PA: Quirk Books.

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Courtesy of Snap-on Industrial - Tools at Height Program, SA03

The LS Starrett Company, SA04, SA05

Section Review Answer Key

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2. a	1.2.1	1b
3. a	1.3.0	1c
4. d	1.4.1	1d
5. a	1.5.1	1e
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Section Four		
1. a	4.1.0	4a
2. a	4.2.2	4b
3. d	4.3.0	4c

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